

1490. p. 109.

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SECOND DISSERTATION
ON
QUICK-LIME
AND
LIME-WATER.

By CHARLES ALSTON, M.D.

The King's Botanist in SCOTLAND, Fellow of the
Royal College of PHYSICIANS, and Professor of Me-
dicine and Botany in the University of EDINBURGH.



EDINBURGH:

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MDCCLV.

A

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ON

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P R E F A C E.

IN this Dissertation I have endeavoured to illustrate, confirm, and improve the former, by a Variety of new Experiments and Observations; and when it was printed off, thought I had done with the Subject; but, on a Revival, observing some Defects and Errors, I think myself obliged to supply and correct them.

By the Preface to the former Dissertation, it appears, that a Ley of equal Parts of Quick-lime and Potash, is much stronger than when less Lime is taken; but whether increasing the Lime will increase the corrosive Quality of the Lixive, and how long they ought to be infused, and in what Proportion of Water, is not there determined. Wherefore,

1. Having procured a sufficient Quantity of Potash, so pure that an Ounce of it did not contain five Grains of Feculencies; I took three Glasses, *A, B, C*, put an Ounce of this Potash into each, and two Gills of Water; and also into *A* 12 Drains, into *B* eight Drains, and into *C* four Drains of the same flaked Stone-lime. When they had stood 40 Hours, and been often stirred, I filtered them into different Phials; and though I weighed a Gill of each several times, I could not observe any Difference in their Specific Gravity. Nor did Spirit of Vitriol, which effervesced strongly with the Lime, as also with *C*, cause any Ebullition in *A* or *B*; though Oil of Vitriol did it with Noise and Heat.

2. I took also three Fragments of one and the same *Calculus*, two of 22 Grains, and one of 21; put them into separate Drinking-glasses, pouring on the first a Spoonful of the Lixive *A*, on the second as much of *B*, and on the third, the lightest, the same Quantity of *C*. When they had stood 24 Hours unmoved, I took out the Fragments; and having separated what was corroded, found that the Fragment in *A* had lost

14 Grains, *B* as much, and *C* 12 Grains. Hence the Strength of *A* and *B* appears to be equal, but to that of *C* as 14 to 12, or as 28 to 24. By the Experiments in the Preface, it was as 28 to 15, owing, probably, to the Impurity of the Potash.

3. I found also, that a $10\frac{1}{2}$ Grains Piece of a *Calculus*, infused 24 Hours in a Spoonful of a Sope-ley which made a great Ebullition with Spirit of Vitriol, had $8\frac{1}{2}$ Grains of its Substance corroded; while another Piece of the same *Calculus*, of equal Weight, infused as long in a Ley of one Part *Alkali*, and three Parts Lime, which made no Ebullition with either Spirit or Oil of Vitriol, had not fully one Grain corroded. Their comparative Strengths, as well as of the Lixives *A*, *B*, *C*, above, were also confirmed by their Action on Silk; though none of them seemed, in a Day's Time, to make any Impression on Linen.

4. I also infused two 10 Grains Fragments of that singular *Calculus* described below, p. 15. the one in a Spoonful of the above Lixive *A*, and another in as much of the same kind of Lixive, which had stood on the Lime but about an Hour, call it *E*. After 15 Hours, *A* was considerably acted on, but *E* very little altered. I took it out, washed it, and put it into a Spoonful of the same Lixive *E*, when it had remained on the Lime 24 Hours; which soon discovered how much its Strength was increased. In a Word, by Experiments, too long to be here related, I found, that the corrosive, or at least lithontriptic Power of the same Sope-leys, in the common Air, 2, 6, and 16 Hours after the Ingredients are mixed, without Heat, is as 3, 8, and 11.

5. Hence it appears, that in order to prepare the most corrosive Lixive, equal Parts of Quick-lime, and of a fixed *Alkali* Salt, ought to be taken, with so much Water, at least, as will yield Lixive equal in Weight to both the Ingredients (*a*), and 16, or rather 24 Hours Time allowed them to act on one another;

(*a*) Vid. infra, No. 64.

which

which ought to be promoted by frequently stirring them during that Time. How far Heat may shorten the Process, I have not tried. "Why an *Alkali* Salt," says a learned Chymist, "when combined with Quick-lime, becomes so highly caustic, I will not attempt to explain. It appears to be one of the most delicate and most difficult Questions in Chymistry; the Solution whereof is little to be hoped for, till the Nature of Lime be much better known than it is at present" (b). Yet even this Question, how difficult soever, I hope Dr Black has already solved, as will appear when his many ingenious and accurate Experiments are published; which seem to throw more Light on that obscure Substance, than all the Labours of the Chymists have done hitherto. Who ever before him attempted to make Quick-lime without Fire, or Lime-water without Quicklime?

6. Since by the Note on p. 52. it appears, that what is called a *dry insipid Calx*, p. 51. is really a Salt; lest it be thence inferred, that there is no Lime in Sopleys, contrary to what is there asserted, it must be observed, that this Salt differs more from an alkaline Salt, than from Lime; which being in Part dissolvable in a Solution of Potash, by N^o 53. this Salt must either be the Lime, so altered by the *Alkali* or the Air, as to be reducible into Crystals; or the Lime so intimately united to Part of the *Alkali*, as to crystallise with it. For I believe no such Salt can be produced from the *Alkali* without Lime. And since this Salt, while in the Form of a Powder, is insipid; as it has but little Taste, when in the Form of a Salt, it might well be called by Dr Hales a *dry insipid Calx*.

7. The Reader must observe an Inconsistency between the Experiments N^o 53. and 55. owing to a Mistake in the latter. For these Experiments being made some time before those which required the Separation of the white Powder, and only with a View to discover, if there was any Difference between the true Salt

(b) Macquer. Chym. prat. 2. p. 152.

of Tartar and what is commonly sold for it; and having observed, that the Papers used in filtering a Solution of 36 Grains of Salt of Tartar in three Gills of Lime-water, after the Powder was separated, had their Weight increased by two or three Grains; I inadvertently took the increased Weight of the filtering Papers N^o 55. after deducting two or three Grains, to be the Weight of the contained Powder, though owing entirely almost, to the Salt remaining in them. For, on repeating these Experiments again and again, I found, that, after washing out the Salt, I could not separate half a Grain of white Powder from the Papers; and that the Weight of the unwashed and dried Papers, was much the same, whether half a Gill of plain Water, or of Lime-water, had been taken. These corrected Experiments, therefore, may either be admitted, in confirmation of N^o 53. and the third Inference, N^o 57. and inserted N^o 55. or both, cancelled, as the Reader pleases. He may also, to make the Argument clearer, p. 31. l. ult. after *Powder*, add, *and the 18th Infusion 10½ Grains*; and p. 14. l. 10. in place of 2 or 300, read, *near 200*; which are all the *Errata* that I have observed. But

I cannot conclude without again owning (a), in Justice to the *Essay*, and to my worthy Friend the Author, that I still esteem it a most useful and laborious Performance, which has done more good in the Stone and Gravel than any thing formerly written on the Subject. It was the *Essay* chiefly that determined me to drink Lime-water, as well as directed to not a few of the Experiments, which I made with a View to improve the Doctor's Plan, and to confirm the extensive Use and Virtues of Quick-lime and its Water. How far I have succeeded, the Reader must judge; and it will be a Pleasure to me to be informed wherein I have failed.

(a) Vid. Diss. p. 4.



SECOND DISSERTATION

ON Quick-Lime and Lime-Water.

THE accidental Discovery of some Qualities of Quick-lime, not formerly observed, put me upon inquiring a little further into the Nature of that obscure Substance; and the Progress therein made I published, by way of Dissertation, in 1752, containing such of the Experiments as appeared to be of any Use, either in Philosophy, or in Physic; which was generally well received.

But, as commonly happens in such Cases, I could not convince every one. Experiments were opposed to Experiments, Inferences to Inferences, and various Methods tried to vilify those new Discoveries, and to erect Theories inconsistent with them. And though Truths founded on Experience can never be overthrown, yet the Defects of faulty Experiments not being obvious to every Reader, I endeavoured, in the second Edition of that Discourse last Year, to lay open and answer every Argument against any thing therein contained, that I could meet with. I have not, however, yet been so happy, as to gain my worthy Friend Dr *Whyt's* Assent. For

Although "to answer my Objections to his Experiments, and my Arguments in favour of my own Notions, was to him an unpleasant Task, and could afford to the Reader but disagreeable Entertainment

At the end of the first Edition

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"ment (a) ;" yet he has animadverted pretty smartly on some of them, and related such Experiments as, in his Opinion, serve to decide the Matters in dispute, against me. But since I must still differ from my Friend, and the Controversy betwixt us, is neither merely speculative nor trifling, having led into several new and curious, as well as useful Truths, of no small Importance in Medicine (b) ; I flatter myself, that an Account of what further Progress I have made in investigating the Properties of that useful, though common Stone, cannot but be an agreeable Entertainment to every curious Reader, while it does Justice to the Dissertation: I shall therefore, as briefly as I can, examine,

1^{mo}, Whether the lithontriptic Power of Shell-lime, or Shell-lime Water, exceeds that of Stone-lime, or Stone-lime Water? 2^{do}, Whether the Strength of Lime-water, if rightly prepared, can be increased by flaking in it fresh Quick-lime? 3^{tio}, Whether the Waters got off Quick-lime grow gradually weaker? 4^{to}, Whether the Powder precipitated on mixing Salt of Tartar with Lime-water, is no other than the calcareous Earth which was before contained in the Water? 5^{to}, Whether Quick-lime communicates to Water a *subtile active Principle*, different from the Matter it throws up in Crusts? And, 6^{to}, Take notice of some other Things in the Essay, to which I cannot agree.

S E C T. I.

1. Dr *Whytt* having determined the dissolving Power of Shell-lime Water, to be near triple that of Stone-lime Water, and founded it on Experiments apparently defective; while Stone Quick-lime is commonly reckoned the strongest, and on that account demanded for Sopes, Caustics, Sugars, &c.; I could not help signifying my Dissent, and did it as modestly as I could; never concealing any Appearance which in the least fa-

(a) *Vid.* Essay on the Virtues of Lime-water, edit. 2. p. 47.

(b) *Vid.* *infra*, No. 22. 68. 85.

voured



voured his Opinion (a). But in order to determine which of these Lime-waters is the strongest Dissolvent of the Stone, or most powerful Lithontriptic, at least out of the Body,

2. Two Pieces of the same *Calculus*, equal in Weight and Figure, ought to be infused in the same Quantities of these two Lime-waters; one, to wit, in the Stone-lime Water, and the other in that made of Shells; both fully impregnated and filtered, contained in the same kind of Vessels, equally stopped or open, and kept for the same Time, in the same Degree of Heat, or rather in the open Air: And the Infusions being at the same time filtered, the *Residuum* in the Papers ought to be equally dried, cautiously examined and compared, by weighing separately what the Water has penetrated, and what not; or the *Nucleus*, if any remains. An Experiment thus managed, and again and again repeated, would be sufficiently decisive as to the comparative lithontriptic Powers of these Lime-waters. But,

3. None of the Doctor's Experiments adduced were thus conducted, not even those on which he founds the dissolving Powers of these Lime-waters in the Table (b): For thus he relates them. "*Exper. 11.* A Fragment of (the *Calculus*) *A* weighing 23 Grains, being put in Stone-lime Water, and kept in a moderate Heat, was mostly all rotten and dissolved in little more than 30 Days. *Exper. 12.* Stone-lime Water that I made by slaking Quick-lime with boiling Lime-water, dissolved a Piece of *A* of five Grains in about seven Days (c). *Exper. 16.* A Piece of *B*, eight Grains, in 36 Hours warm Digestion in Oyster-shell Lime-water, had about $3\frac{1}{4}$ Grains of its Substance dissolved (d)."

Now, although the Doctor pretends by these Experiments to prove the dissolving Powers of these three Lime-waters to be as 100, 130, and 296 (e); yet e-

(a) *Vid.* Diss. p. 2. 39. 55. 73.

(b) *Ess.* p. 178.

(c) *Ess.* p. 27. & 28.

(d) *Ess.* p. 30.

(e) *Ess.* p. 178.

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very Reader must see how defective they are, and that no such Consequence can be drawn from them. But,

4. It is still more remarkable, that these very Experiments, if they prove any thing, prove the dissolving Power of single Stone-lime Water, to be the greatest of the three. For, (1.) If single Stone-lime Water, in 30 Days, dissolved 23 Grains, it certainly in seven Days dissolved more than five Grains; because $30 : 23 :: 7 : 5.3$; especially seeing "the Virtues of Lime-water are weakened in proportion to the Quantity of the Stone dissolved (a);" and consequently the dissolving Power much greater the first seven Days than the second, Hence the dissolving Power of single Stone-lime Water is greater than that of the double. Again,

(2.) Seeing "Gravel-stones seem to dissolve no more in Lime-water, after the first eight or ten Days, though kept in a Heat of about 100 Degrees of *Fahrenheit's* Thermometer (b)," the 23 Grains dissolved in *Exper.* 11. must have been all dissolved in 10 Days; and consequently there was dissolved in 36 Hours at least $3\frac{2}{3}$ Grains; because $10 : 23 :: 1.5 : 3.4$. The dissolving Power of single Stone-lime Water, therefore, is greater than that of single Shell-lime Water, by these Experiments. But,

5. (3.) The dissolving Power of single Stone-lime Water must also be greater than that of double Shell-lime Water: For the Doctor "found, that a Piece of "a *Calculus* of 10 Grains put into double Shell-lime Water, after it had stood warm 93 Hours, had only "two Grains of its Substance dissolved or rotten (c);" whereas the single Stone-lime Water must have dissolved in three Days $2\frac{3}{6}$ Grains, and in 93 Hours near three Grains, though it had dissolved no more the first three Days than it did the second, &c.; and by N^o 4. 2. no less than seven Grains must have been dissolved in that Time.

I do not, therefore, see how these Experiments can

(a) *Ess.* p. 31.

(b) *Ess.* p. 129.

(c) *Ess.* p. 41.

support the Proportions which the dissolving Powers of the *Menstruums* bear to one another, as stated in the Table (a); nor how any Calculation can supply their Defects. As for the Grounds on which the Table is built (b), to me they appear to be very sandy; several material Circumstances being omitted, as Quantity of the *Menstruums*, Degree of Heats, Figure of the Fragments, &c. (c); without which an exact Calculation of their Powers appears to me to be impossible.

And though the Doctor has been at a great deal of Pains to find out the specific Gravities of different Lime-waters (d), which are of no Consequence in the present Question, his Ley being a third stronger than *Glasgow* Sope-ley, though specifically much lighter (e); yet he has been at very little to discover the lithontriptic Power of Stone-lime Water: For after giving the respective Weights of single and double Shell-lime Waters of the first Infusion, of Shell-lime Water of the fourth Infusion, and of Stone-lime Water, adds, "I put three Pieces of
" a very hard *Calculus*, each weighing 10 Grains, into
" three different Phials; one of which I filled with
" single, another with double Shell-lime Water, and
" the third with the Shell-lime Water of the fourth
" Infusion. After they had stood in the same Degree
" of Warmth 93 Hours, I found that the *Calculus* in
" the double Lime-water had two Grains of its Sub-
" stance dissolved or rotten, the *Calculus* in the single
" Lime-water had lost somewhat more than a Grain
" and a half, and the third a Grain (f)." And though it was certainly of more Consequence to discover the lithontriptic Power of Stone-lime Water, than its specific Gravity; yet, as if he had a Prejudice against it, here he omitted to put a Piece of the same *Calculus* into the Stone-lime Water, or to relate the Event. However, by these three Infusions, the dissolving Powers of double, single, and fourth Shell-lime Wa-

(a) Ess. p. 178.

(b) Ess. p. 176.

(c) See above, No. 2.

(d) Phys. Ess. p. 374.—377.

Ess. p. 39.—41.

(e) Ess. p. 107.

(f) Ess. p. 41.

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ters, are as 4, 3, & 2; Proportions reconcilable with none of the Tables.

6. The Imperfection of the Doctor's Experiments appears also on repeating them: Of which there is a notable Instance, *Eff. p. 111. 112. (a)*; and another, *Eff. p. 32. 33.*; where, though he had proven, by as accurate Experiments as any in the Essay, that the lithontriptic Power of Lime-water made of one Part Shell-lime, and seven Parts Water, is to that made of one Part Shells, and ten Parts Water, as 7 to 5; yet, in a Note added (*b*), he says, "Further Experiments have convinced him, that the Difference of Strength will be inconsiderable, whether 8, 10, or 12 times its Weight of Water be poured on the Lime; provided the Water be allowed to remain long enough on it, to be fully impregnated with its Virtues; the Neglect of which seems to have been, in a good measure, the Reason of the remarkable Difference between the dissolving Powers of the two Lime-waters last mentioned." Might not then the same Neglect, so long not observed by him, or some other no less considerable one, as of mixing well the Lime with the Water, have been the Cause of the remarkable Difference between the dissolving Powers of Stone and Shell Lime-waters? And,

7. That this is not a mere Conjecture, appears by comparing the dissolving Powers and Strengths of these Lime-waters, as stated in the Tables, *Eff. edit. 1. p. 154. Eff. edit. 2. p. 178. & p. 59.* For, according to these Tables, the dissolving Power and Strength of the Lime-waters following, are,

	T. 1.	T. 2.	T. 3.
Stone-lime Water - - -	202	100	10
Strong Stone-lime Water - -	262	130	11 $\frac{1}{2}$
Shell-lime Water - - -	583	296	13
Double Shell-lime Water - -	666	338	15

Now, how the Strength of Shell-lime Water can be to that of Stone-lime Water as 13 to 10, and the

(a) *Vid. Diff. p. 53.*

(b) *Eff. edit. 2. p. 34.*

dissolving

dissolving Power of the one, to the other, as 296 to 100, wants much to be explained; for, as I understand it, I see not how any Experiments can prove it. Yet the Doctor adds,

“Nor is Stone-lime Water only inferior to Shell-lime Water in its lithontriptic Virtue, but also as it is less homogeneous and safe; since the Lime-stone may be impregnated with metallic or mineral Principles, which even the Fire may not be able wholly to destroy (a).” But,

8. Such metallic or mineral Principles have not yet appeared to make Stone-lime Water unsafe. And since it has been much longer used than Shell-lime Water, and its Success in several other Diseases, as well as in the Gravel, sufficiently experienced; if there be any such Principles in Stone-lime, there is Reason to believe, that they are not only quite safe, but also contribute to those salutary Effects of Stone-lime Water, to which, according to the Doctor, Shell-lime Water can have no Claim. He often celebrates Shell-lime Water for its rotting the *Calculus*, corrupting the animal Oils, putrifying the Juices, &c.; whereas, among the good Qualities of Stone-lime Water, are to be numbered its penetrating, without rotting, the *Calculus*; its purifying the Oils, and resisting the Putrefaction of the animal Juices. And,

9. Good Dr *Hales* lately informed me, that it appeared by the Experiments which he had made, that neither Shell-lime nor Chalk-lime will preserve Water from Putrefaction, though Stone-lime does. And, among many Experiments confirming this Property of Stone-lime, I shall mention only one. Nov. 27. I filled with Water a five Gallon Beer-cask, and put into it three Ounces of six Months old slaked Stone-lime; and though it stood in a warm Room six Months, there never appeared in it the least Tendency to Putrefaction. This Quality surely can never render Stone-lime Water less safe than Shell-lime Water; yea, it ought to render

(a) *Ess.* p. 32.

it more safe, and more effectual too, even in the Stone: *Quodcumque enim putrefactionem, ac ideo salis volatilis evolutionem, aut productionem in chylo et in sanguine cohibebit, calculorum generationem præpediet* (a). Which Shell-lime Water does not, according to the *Essay*, p. 25. 26.

And it deserves well to be remarked, that Mr *David Miller's* Case, as related *Essay*, p. 5. &c. is a more notable Instance of the Success of Stone-lime Water in breaking and bringing away the Stone, than any hitherto adduced for Shell-lime Water, that I have heard of. Its Inferiority, therefore, as a Lithontriptic, wants yet to be proven, as well as its being less homogeneous and safe. Whereas, on the other hand,

10. We find that Shells not only may be, but, according to the Doctor, really are impregnated with heterogeneous Substances; for Instance, Sea-salt, where-with "Oyster-shells, even after Calcination, much "abound (b);" also, as we calcine them, Coal-ashes, and something else, like red Oker, commonly adheres to them; which very much sully the first Infusion, and which therefore I commonly throw away; besides the nauseous, not to say noxious *Empyreuma*, which many Calcinations are not able sometimes wholly to destroy. For

Oyster-shells are not all equally calcinable, whether recent or old (c). Some in six or eight Hours, in a strong Fire, may be so well burnt as not to infect the Water with this detestable *Empyreuma*; while others cannot, in I do not know how many such Calcinations. Whether this is to be attributed to the different Proportions of the Salts or Sulphurs contained in the Shells, or to some Disease in the Oyster, or to some other Cause, I cannot determine: For it cannot be owing to incompleat Calcination only; because I have often observed it very strong in the Lime-water made of Shells so fully burnt, as to grow hot, and with Noise split, and fall down into Lime in the Water,

(a) Geoff. M. M. 1. p. 104.

(b) *Ess.* p. 82.

(c) *Vid.* Pref. Diss. p. viii.

that

that is, were compleat Calx vive; while the Lime-waters prepared of Shells, which give none of these Signs of a thorough Calcination, are not seldom quite free of the *Empyreuma* (a). The Doctor asks,

“Are not the Particles of Shell-lime more subtil, saponaceous, and penetrating, than those of Stone-lime? Does not Shell-lime Water partly owe its greater dissolving Power to this? And because it is naturally saponaceous and penetrating, is not the Effect of Sops upon it less remarkable than on Stone-lime Water, which is more devoid of these Qualities (b)?” But since, according to the Doctor, it is the active Principle which Lime-stone and Shells receive from the Fire, which gives to Quick-lime and Lime-water their peculiar Taste and Virtues, and which is strongly attracted by alkaline Salts, while the earthy Part of Quick-lime is rejected by them (c); the Particles of the Lime have nothing to do here; they are the earthy Part of it, and the same in exhausted Lime and Lime-crusts, after they have received from the Fire the *active Principle*, that they were before the new Calcination. Hence these three extraordinary Questions may all be answered *negative*. But, more particularly,

11. (a) The Subtily of the Particles of either not being discoverable by our Senses, we may conjecture as we will; but if we can no other ways explain their Virtues, but by the imagined Subtily of their Particles, we had as well let it alone. And since slaked Stone-lime is as fine a Powder, yea commonly much finer, than Shell-lime; it may be asked, with as good Reason, Are not the Particles of Stone-lime more subtil and penetrating, &c.? Again, the Particles of Shell-lime, while clogged with the empyreumatic Sulphur only, can in any Sense be called *saponaceous*; but this must render them less subtil and penetrating.

(b) As to the second Question, the Doctor himself

(a) Vid. infra, No. 79.

(c) Vid. Ess. p. 100.

(b) Ess. p. 113.

seems to put a Negative upon it, by denying that Lime-water dissolves the *Calculus* by its penetrating Detergency (a). And, (c), that the Effect of Sope on Shell-lime Water should be less remarkable, that is, should not increase its lithontriptic Power, as it does that of Stone-lime Water, because it is naturally more saponaceous, is altogether new to me, who always imagined, that *similia juvantur similibus*. The Effect of Sope on hard Water is less remarkable than on soft Water; is it therefore more saponaceous? But if Stone-lime Water be less saponaceous than Shell-lime Water, it must certainly be more detergent and penetrating; since it sensibly increases the Virtues of Sope, which Shell-lime Water does not (b).

12. The Doctor's ingenious Friend has observed, that Shell-lime Water corrodes Linen faster than Stone-lime Water (c). The same learned Gentleman has also observed, that Potash corrects this corrosive Quality; yet Sope-ley is a stronger Dissolvent of the *Calculus* than Lime-water (d). And the more corrosive any Lime-water is, it must be the less safe in every Disease. Neither can the greater Degree of Hardness (e) prove a greater dissolving Power in Shell-lime Water; but rather that it is less detergent and penetrating than Stone-lime Water. But

“ Mess. *Du Hamel* and *Grosse* found, above 20 Years ago, that a greater Quantity of Tartar was dissolved “ by Oister-shell Lime-water, than by that made with “ Stone-lime (f).” Granting it were so, it can only be thence inferred, that it is more antacid, not that it is more lithontriptic. Potash is a much stronger Solvent of Tartar than any Lime-water; is it therefore more lithontriptic?

13. I divided 86 Grains of Crystal Tartar into two equal Parts; put them into two Phials, whereof one contained a Gill of Stone-lime Water, and the other

(a) *Vid. Ess. p. 134. See below, No. 80.*

(b) *Vid. infra, No. 83.*

(c) *Vid. Ess. p. 58.*

(d) *Vid. Ess. p. 53.*

(f) *Vid. Ess. p. 53.*

(d) *Vid. Ess. p. 97.*

as much Shell-lime Water. When they had stood 24 Hours, and been frequently shaken, I filtered, dried, and weighed the *Residuum*; and there remained of each undissolved just 41 Grains. Hence neither of these Waters can be called a powerful Solvent of Tartar; it requiring near 900 Grains of Lime-water to dissolve one Grain of the Crystals in a Day's Time. If therefore Lime-water dissolves Tartar pretty quickly (a), its Action must be very soon over. Now,

14. Having answered all the Arguments for the superior Strength and Safety of Lime-water made of Shells, I cannot help thinking, that the Doctor has not chosen the properest Method to discover or prove it. In my humble Opinion, he ought rather to have renewed some of his Experiments, particularly N^o 11. 12. 16. with all the necessary Circumstances (b); the Neglect whereof he seems to regret (c); which, instead of requiring 70 or 80 Days to finish them (d), and five Pages to relate them, might have been performed in a Week, and contained in a Page. For although all should be granted which the Doctor has advanced, concerning the specific Gravities of various Lime-waters, their different Precipitations with Salt of Tartar, &c. as quite beyond all Exception, (which however they are not, as will afterward appear); yet no Conclusion could thence be deduced sufficient to invalidate, even one single Experiment, if right executed. I shall therefore relate a few pretty accurate ones, which I think may decide the Question, and clear up the Action of Lime-water on the *Calculus* out of the Body.

15. Having observed several times, that small *Calculi*, put in a Glass of Lime-water, covered with Paper only, were in a few Days remarkably penetrated (e); and that Lime-water thus exposed, in 24 Hours loses a fourth Part of its Lime in Crusts, and consequently a fourth of its Strength, in a few Days becoming no bet-

(a) *Vid. Ess. p. 38.*

(b) *Vid. No. 2.*

(c) *Vid. Ess. p. 175.*

(d) *Vid. Ess. p. 47. &c.*

(e) *Vid. Diss. p. 38.*

ter than common Water; I thought, if such *Calculi* were infused in Lime-water, in corked Glasses, or Phials, to which the Air had no Access, the Action of the Lime-water would be much greater, and longer continued. Accordingly, I made many Experiments with Fragments of Gravel-stones in corked Glasses; But none of them answered Expectation; none were near so much penetrated, in much longer Time, as were the *Calculi* in open Drinking-glasses. This I attributed to the Nature of the Stones, which were indeed very hard and solid; and I believed there were some whereon Lime-water could make no Impression (a).

16. But finding afterwards, that this would not account for some of the *Phænomena*; particularly, why the Fragment in the Shell-lime Water, to which the Air had some Access, and formed Crusts, was much sooner, and apparently more penetrated, than the Fragment in the Stone-lime Water, to which the Air had no Access. And whether to ascribe it to the Shells, to the Air, or to elementary Water, I knew not (b); and had still continued ignorant, had I not been, by Accident, obliged to renew the Experiment in open Drinking-glasses. For,

17. January 7. 1755. To know what Effect tartarified Lime-water (c) would have on the *Calculus*, having no empty Phials by me, I put half a Gill of tartarified Shell-lime Water into one Drinking-glass, and as much plain Shell-lime Water into another; and into each a roundish eight Grains Fragment, of the same *Calculus*, with which I had made several Experiments in corked Phials. I took little Notice of them till January 14.; when the Fragment in the Shell-lime Water had the same Appearance with the *Calculus*, *Diff.* p. 38, being all covered, as it were, with snowy Flakes; while the Fragment in the tartarified Lime-water was quite smooth, no bigger than when put into the Wa-

(a) *Vid.* *Diff.* p. 40.

(b) *Vid.* *Diff.* p. 74. *Pref.* p. vi.

(c) *Vid.* *infra*, No. 54.

ter, and only whitened. This Effect of the Air deserving to be further inquired into,

18. *February 17.* I put into three Drinking-glasses, *A, B, C,* three Fragments of the same *Calculus*, of $9\frac{1}{2}$ Grains each, and no regular Figure; and into *A* half a Gill of Shell-lime Water, into *B* as much Stone-lime Water, and the same Quantity of tartarised Shell-lime Water into *C*; covering them with Paper only. Next Day, the Fragment in *A* was almost covered with the snowy Grains, and visibly more penetrated than a Fragment of the same *Calculus*, in the same Lime-water, in a corked Phial, which had stood since the 18th of *December* preceding; that is, the lithontriptic Power of Lime-water in an open Glass, is more than 60 times greater than in a corked Phial; or it penetrates the *Calculus* more in one Day in the Glass, than in 60 Days in the Phial. The Fragment in *B* had fewer and smaller white Grains than *A*, but numerous crystalline *Spicula* issued from it (*a*). The *Calculus* in *C* was only a little whitened. Again,

19. *March 7.* Having put two Pieces of the same *Calculus*, of $7\frac{1}{2}$ Grains each, into two equal Drinking-glasses, I filled the one with tartarised Stone-lime Water, and the other with tartarised Shell-lime Water, covering them with Paper as before. *March 10.* the Fragment in the Stone-lime Water appeared to be more penetrated than the other; but when both were dried and brushed, each weighed just seven Grains.

April 7. I put into *A*, one of the Glasses N^o 18. half a Gill of plain Stone-lime Water, into *B* as much tartarised Stone-lime Water, and a like Quantity of tartarised Shell-lime Water into *C*; and having two pretty similar Pieces of a *Calculus*, of 14 Grains each, I put one into *B*, and the other into *C*, and into *A*, two Fragments of the same *Calculus*, weighing together 14 Grains. *April 14.* I poured off the Waters, washed and dried the remaining Fragments. *C* weighed 13 Grains, *B* scarce so much, and *A* $11\frac{1}{2}$ Grains. Hence

(a) *Vid. Ess. p. 82.*

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the Stone-breaking Power of plain Stone-lime Water, may be reckoned at least double that of tartarised Shell-lime Water; $A : C :: 2 : 1$. And,

20. Because in the Experiment N^o 18. Shell-lime Water seemed to penetrate the *Calculus* more than Stone-lime Water, in order to discover whether this was owing to the Nature of these Waters, or accidental only, I made the following Experiment, with the two Lime-waters, which I commonly drink. After their respective Limes had yielded 2 or 300 times their Weight of Lime-water, and having observed every Circumstance necessary to the complete Saturation of the Waters (*a*), I reduced two Fragments of the same *Calculus* nearly to the same Figure, and exactly to the same Weight of 13 Grains; put them into two Drinking-glasses, and poured on the one Half a Gill of the Stone-lime Water, and on the other as much of the Shell-lime Water; covered them with Paper, and set them in a North Window. After they had stood macerating a Week, and I had prepared two Filtrés, of the same gray Paper, and equal in Size and Weight, I filtered, dried, and carefully examined and weighed the Remainders; and found that each Paper had its Weight increased near $14\frac{1}{2}$ Grains, that the *Nucleus*, or unpenetrated Part of each Fragment, weighed $10\frac{1}{2}$ Grains, and the white Powder, separated from each Paper, three Grains, without the smallest Difference. Hence any real Difference of Strength between Stone and Shell Lime-waters, is merely accidental (*b*), and owing to some Fault or Oversight in the Manner of preparing them. Again,

21. After the Fragments mentioned *Pres. p. vi.* had stood in their corked Glasses more than a Year, I took them out; and having separated all that was penetrated, the remaining *Nucleus* of the Shell-lime Water weighed 18 Grains, but that of the Stone-lime Water only 14 Grains. So the Fragments, when put into the Waters, weighing each 36 Grains, the Shell-lime Wa-

(*a*) *Vid.* No. 38.

(*b*) *Vid. infra*, No. 38.

ter had penetrated only 18 Grains, but the Stone-lime Water 22 Grains. So here the Action of the Stone-lime Water on the *Calculus*, to that of Shell-lime Water, is as 7 to 6: For $22 : 18 :: 7\frac{1}{3} : 6$. Also

It is observable, that the Fragments put into the Lime-waters in corked Phials Dec. 18. began not to shew their snowy Efflorescencies before the Beginning of May; and before the End of that Month, the Fragment in the Stone-lime Water appeared to be considerably more acted on than the other. I have also observed, that Lime-water sometimes penetrates more the harder than the softer Part of the *Calculus*. Mr *Adie* gave me four Stones, all taken from a seven Year old Boy; the outer Coat whereof was in Colour and Grain not unlike common Loaf-sugar, about $\frac{1}{3}$ of an Inch thick, and so friable, that I could, with my Fingers, rub like white Sand from it; within which was contained a hard, fine-grained, sand-coloured *Nucleus*. One of these Stones I sawed through the middle; and as they were pretty equal in Figure, I reduced them to the same Wight of 41 Grains; infusing one in a Glass of Stone-lime Water, and the other in the same Quantity of Shell-lime Water. There appeared little Alteration in either for several Days; yea, after 18 Days, the outer Coat was only a little whiter than at first; but the much harder *Nucleus* emitted the snowy Grains as usual, and had lost each of their Weight, when washed and dried, only half a Grain, very little of the *Nucleus* being exposed to the Influence of the Water.

22. From these Experiments (a), we may infer, 1^{mo}, That since the Air, which, *pistilli mechanici instar, movet, conterit, permiscet omnia* (b), much increases the lithontriptic Power of Lime-water, and the Action of every *Menstruum*, it cannot be thought to diminish that of Water on Quick-lime. And since no artificial Heat can be every way so equable as is that of the Air, there cannot be, perhaps, a better Way of discovering the Stone-breaking Powers of Lime-waters,

(a) *Vid.* No. 17. 18. 19. 20. 21. (b) *B. Chem.* i. p. 537.

Et. than by infusing the *Calculi* in them, in open Glasses, without any artificial Heat.

2do, That tartarised Lime-water is a much weaker Lithontriptic than plain Lime-water; though so acrid and disagreeable, as to be very unfit for inward Use, unless so diluted and softened, as to have little or no Effect on the Stone; which must be equally true of Sope-ley (a). Hence the Doctor's *subtile active Principle*, of which more *Sect. v.* is effectually undermined; and consequently his Account of the *Constitution* of Sope-ley, of the *Action* of alkaline Salts on Quick-lime, of the *Virtues* of the common Caustic, &c. (b), built on it, must all tumble with it (c). Hence also it follows, that all the earthy Part of Lime, that is, all the Lime, is not precipitated from Lime-water by Salt of Tartar (d), in whatever Proportion they are mixed; perhaps not one Half of it; tartarised Lime-water having near Half as great a Power of breaking the Stone as plain Lime-water; a Quality the Doctor will not attribute to the alkaline Salt.

3tio, That although, in Complaisance to my good Friend, I have sometimes, in treating of the Action of Lime-water on the *Calculus*, made use of the Terms *Solvent and Dissolvent*; yet, as is observed *Diff. p. 38.* very improperly: For the Parts of the Stone are not dissolved by it, but only separated, as the Parts of Boles are by Water; each Particle retaining its Proportion of all the Principles, the volatile Salt not excepted. For if this Salt were volatilised by Lime-water, it would be discoverable by the Smell, but especially by the Weight. But as I have not observed it emit any urinous Vapours, so it is as heavy when reduced to a white Powder, as when in a solid Mass. Lime-water, therefore, may be said to dilute, or penetrate, or break the Stone, more properly than to dissolve it. And,

4to, That although from the lithontriptic Power of

(a) *Vid. Ess. p. 142. 143. and below, No. 68.*

(b) *Vid. Ess. p. 96. 97. 98. (d) Vid. Sect. iv.*

(c) *Vid. infra, No. 70.*

Lime-waters out of the Body, we may with sufficient Certainty determine their comparative Strength; yet it is but a lame Conjecture we can thence draw as to their Effects inwardly taken; since, notwithstanding their remarkable and pretty sudden Action on the *Calculus* in the open Air, they have so little Influence on it in a corked Phial.

S E C T. II.

23. That Water fully impregnated with Quick-lime cannot be made stronger, by slaking fresh Quick-lime in it, appears to me to be as certain, as that common Water, which has dissolved as much Sea-salt as it can hold, will not become saltier by putting more Salt in it; or that Water will not dissolve more Salt than it can dissolve. Yet my Friend attempts to refute this, even out of the Dissertation.

“ Dr *Alston* owns,” says he, “ that having weighed
“ some quadruple Lime-water (which, by the by, from
“ the small Proportion of Lime added each Time to
“ the Water, should not have been so strong as our
“ double Lime-water *B*, p. 39.) in a Flask, which
“ contained 8940 Grains of single Lime-water, he
“ found its Weight to be 8947 Grains, *Diff.* p. 61.” (a).
But here the Doctor seems to have forgotten, that
“ further Experiments have convinced him, that there
“ is no need of being very nice as to the Quantity of
“ Water to be added to Quick-lime; since the Dif-
“ ference of Strength will be inconsiderable, whether
“ 8, 10, or 12 times its Weight of Water is poured
“ upon it; provided the Water be allowed to remain
“ long enough on the Lime, to be fully impregnated
“ with its Virtues (a).” Without any considerable
Difference of Strength, therefore,

24. His Pound of calcined Oyster-shells might have impregnated 12 as well as 7 Pounds of Water; and the additional Half-pound of calcined Shells, fix as well as

(a) *Ess.* p. 55.

(b) *Ess.* p. 34. Note x.

two Pounds. Now, as 24 Ounces of the Doctor's Shells are to 18 Pounds of Water, so are six Ounces of our Shells to $4\frac{1}{2}$ Pounds of Water; though two Pounds only were taken, and these too not of common, but of Lime Water. Besides, the Doctor allowed the Water to remain on the first Lime only 11 Hours, and on the second 13 Hours; whereas our Water remained on the first Shells several Days, on the first additional Shells three Days, on the second two, and on the third one Day. So, if the Strength of the Lime-water could be thus increased, our quadruple should have been stronger than his double Lime-water. He adds,

"But though the Doctor is at last *convinced*, by the Force of his own Experiments, that double Lime-water may be heavier than single; yet he will not allow even the very small Excess of Gravity in his quadruple Lime-water to be owing to its containing more of the Lime than single Lime-water, but to some heterogeneous Substances dissolved in it. And this *he thinks* he has proved, by finding, that the Flask *filled* with this quadruple Lime-water, after it had thrown up its Crusts, exceeded the same Flask *filled* with common Water by four Grains (a)."

25. That heterogeneous Substances may make double Lime-water heavier than single, I never doubted: But what Experiments convinced me of was, that Pit-coal-ashes was such a Substance; that the quadruple Lime-water, after it had thrown up the Lime, was as much heavier than Fountain-water, as it was heavier than single Lime-water, while the Lime remained in it; that Ashes, and commonly something else like red Oker, adhere to the Shells calcined in a common Fire; and hence, that the Weight of the quadruple Lime-water was in part owing to such heterogeneous Substances; because I had found by Experiments, that Stone-lime Water, after it had thrown up all its Lime in Crusts, and differed nothing from common Water, was neither heavier nor lighter than the Fountain-wa-

ter of which it was made (a); though there was Reason to believe, that it should really be lighter. Again,

26. By the *Diff.* p. 61. cited by the Doctor, it is evident, that I did not *fill* the Flask with the quadruple Lime-water; for the Words there are, "I weighed in the Flask three Gills of the effete Lime-water, and found it about 5368 Grains; that is, four Grains heavier than three Gills of Fountain-water;" which wants 3572 Grains of what the Flask could contain of single Lime-water. On this Mistake is founded another: For the *Essay* goes on thus.

"Even this Experiment, supposing it were liable to no Objection, accounts only for about *one Half* of the Difference of Weight between the Doctor's single and quadruple Lime-water (b)."

27. But it accounts for the whole Difference to the third part of a Grain. For if a Measure of 5368 Grains of the effete quadruple Lime-water, was four Grains heavier than the same Measure of Fountain-water, a Measure of 8947 Grains of this effete Lime-water, must be $6\frac{2}{3}$ Grains heavier than the same Measure of Fountain-water; since $5368 : 4 :: 8947 : 6.65$. And thus I considered the Difference as accurately as I could. Yet it follows,

"But if we consider the Thing *more accurately*, we shall see that no Stress can be laid upon it. For, not to mention, that if the single Lime-water had been weighed after throwing up its Crusts, it might *perhaps* have differed not much less from common Water in specific Gravity, than the quadruple Lime-water did; was the Doctor sure this last Water was quite effete? I found, that, after 19 Days Exposition to the open Air, 12 Ounces of strong Lime-water, upon being mixed with eight Grains of Salt of Tartar, afforded $1\frac{1}{2}$ Grains of calcarious Matter; when 30 Grains of the same Salt dissolved in common Water, did not afford $\frac{1}{2}$ Part of that Quantity. Is

(a) See *Diff.* p. 10.

(b) *Ess.* p. 56.

“ it not therefore more than probable, that the four
 “ Grains, by which the effete quadruple Lime-water
 “ exceeded common Water in the Doctor’s Experi-
 “ ment, were partly, if not wholly, owing to its not
 “ being entirely deprived of the Lime; and this the
 “ rather, that he only exposed this Lime-water ten
 “ Days to the open Air (a)?”

28. I hope what I have said will satisfy the Doctor, both as to his greater Accuracy and Conjecture. To his Query it is answered, That I was as sure this last Water was quite effete, as several Experiments of this kind could make me. It stood longer in a Bowl than I ever found necessary for Lime-water in it, to free itself of the Lime; it being near six Inches in Diameter above, and not two deep (b). The Lime-water was frequently stirred, and threw up nothing visible, for some Days before it was filtered. And the Doctor found, that Lime-water, exposed in an open Vessel only five Days, “ neither changed the Colour of Syrup of Vio-
 “ lets, nor had any Effect in dissolving the Stone (c);” consequently had then lost its calcarious Matter, and therefore was effete (d). So whether the Doctor’s 1½ Grains of calcarious Matter came from the Lime, or from Ashes, I am not concerned to inquire; since he neither describes the Vessel in which he exposed his strong Lime-water, nor mentions his breaking the Crusts; and since I found, that one Part of our common Coal-ashes, infused in 12 Parts of Water, communicated so much of their Substance to it, that four Ounces of this Water, though filtered through gray Paper, mixed with 10 Grains of Salt of Tartar, precipitated also 1½ Grains of white Powder.

“ What is here suggested,” says he, “ may shew,
 “ why Dr *Alston* did not find a *sensibly* greater Quanti-
 “ ty of Crusts in double than in single Lime-water;
 “ and that the Strength of Lime-waters cannot be ex-
 “ actly determined by the Quantity of Crusts which

(a) Ess. p. 56. 57.

(b) Vid. Ess. p. 76.

(c) Ess. p. 76.

(d) Ess. p. 171.

“ they

“ they throw up, *unless the Water is either evaporated,*
“ or allowed to stand till it give no more Precipita-
“ tion with Salt of Tartar, than common Water;
“ neither of which Methods were observed by the Doc-
“ tor in his Experiments” (a).

29. And the Answers to these Suggestions may shew,
that there is not a sensibly greater Quantity of Crusts
in double than in single Lime-water, if prepared as it
ought to be (b): Nor did Dr *Whytt* find it (c). And
if the Strength of Lime-water be proportional to the
Quantity of Lime contained in it, the Crusts only,
compared with the undissolved Lime, can discover it;
but neither Evaporation, nor Precipitation with Salt
of Tartar (d): Which, therefore, being of no Use
here, needed not be observed. But since the Doctor lays
so much Stress on Precipitation, let us compare some
of his Experiments of this Kind.

“ Twenty Grains of Salt of Tartar, mixed with
“ eight Ounces and two Drams of *double* Shell-lime
“ Water, (made of one Part fresh calcined Oister-
“ shells, and seven Parts single Shell-lime Water), which
“ had stood 24 Hours on the Lime, by Precipitation
“ gave eight Grains of white Powder” (e). “ I pour-
“ ed upon four Ounces of Oister-shell Lime rather more
“ than eight times its Weight of Water. After 24
“ Hours, I filtered 12 Ounces and one Dram, *Avoirdu-*
“ *pois* Weight, of this Lime-water through brown
“ Paper, and added to it 30 Grains of Salt of Tartar.
“ The white Powder which fell to the Bottom, being
“ separated from the Water by Filtration, and well
“ dried, weighed full 13 Grains” (f): That is, *single*
Shell-lime Water affords, by Precipitation with Salt
of Tartar, above a twelfth Part more of white Pow-
der, than *double* Shell-lime Water; and consequently,
according to the Doctor’s Experiments and Theory, is
a twelfth Part stronger.

As for Evaporation, it can never discover the Quan-

(a) Note * on Ess. p. 57. (b) Vid. Diff. p. 8.

(c) Phys. Ess. p. 379. Diff. p. 65.

(d) Vid. Diff. p. 8. & 67. and No. 46. &c. below.

(e) Phys. Ess. p. 376. & 378. (f) Ess. p. 47.

tity of Crusts (a); Nor does it seem to make any thing for the Doctor's Purpose; since, in the second Edition of his Essay, I cannot find the 66th, and Part of the 67th Page of the first Edition, wherein he gave an Account of Dr *Langrish's* Experiment this Way (b). And that the superior Strength of double above single Lime-water, as a Lithontriptic, is not proved by the Doctor's Experiments, is shewn above, N^o 3. 4. 5. But the Doctor adds,

"When the Difference of specific Gravities amounts only to a few Grains, one cannot safely rely on such a Machine as the Doctor used; and to set it up in opposition to the hydrostatical Balance, would be much the same, as if one should contend that he could describe a Circle as accurately without Compasses as with them" (c). I have said enough of specific Gravities, *Diff.* p. 50. & 59. But since the Doctor still insists on them, it is not amiss to compare our Machines.

30. The Doctor's hydrostatical Balance was a large Glass Phial filled with Sand, and hermetically sealed; which he weighed (in a good common Balance certainly) first in the Air, wherein it must have exceeded 4500 Grains; since immersed in Fountain-water, it lost of its former Weight 3704, and afterwards in the different Lime-waters (d).

My Machine was a Glass Flask, weighing, with its proper Cork and String, only 814 Grains. When I wanted to know how much of Lime-water, or any other Liquid, it could contain, I first counterpoised it exactly, and then filled it quite full; that thrusting in the Cork, so far as it could go, which was to a certain Depth only, it might fill the Place of the Liquor running over, without leaving the smallest Bubble of Air. Thus I weighed it in such a Balance as I had, but always in the same Scale, and with the same Weights.

31. And I cannot but think, that the Phial full of

(a) *Vid. Diff.* p. 67.

(b) *Vid. Diff.* p. 52.

(c) *Ess.* p. 57.

(d) *Ess.* p. 39. 40.

Water, might be weighed as accurately in the Air, as when full of Sand, and the Flask as accurately as the Phial; and also, that the Doctor was as liable to Errors, from the Inaccuracy of the Weights, &c. as I was; especially since it does not appear, that his Lime-waters, C and D, were fully impregnated with the Lime (a). For how otherwise could his hydrostatical Balance differ so widely from Mr Boyle's, or so much from his Copper Vessel of 13055 Grains (b)? However, if my Machine may be set up in opposition to the Doctor's hydrostatical Balance, with as good Reason as any one may contend to describe a Circle as accurately without Compasses as with them, I ask no more; though far from thinking the Strength of Lime-waters can be determined by their specific Gravities (c).

S E C T. III.

32. I say in the *Dissertation*, Experiments have convinced me, that one Pound of fully-calcined Calx vive may impregnate some hundred Pounds of Water, and as strongly too, so far as I could discover, as it can eight or ten; one Part of it being sufficient for 5 or 600 Parts of Water, if the Quick-lime be fresh, and free of heterogeneous Substances; as well as fully calcined (d). Which Experiments (e) are confirmed by Dr Whytt's, *Ess.* p. 43. (f), especially by making Lime-water in a Bottle (g). But, says the *Essay*,

“ It seems to have been the common Opinion, that
“ the first and second Waters got off Quick-lime are not
“ only the strongest, but that the third, fourth, and
“ succeeding ones, are almost insipid, and destitute of
“ any Virtue. But Dr Alston has lately informed us,
“ that Quick-lime not only continues to communi-
“ cate its Virtues to Water much longer than any one
“ had imagined before, but also affirms, that the last

(a) Vid. infra, No. 37.

(d) Vid. Diff. p. 4. 12. 29. 30. 55.

(b) Vid. Diff. p. 59.

(e) Vid. Diff. p. 5. & 8.

(c) Vid. supra, No. 5. & 14.

(f) Vid. Diff. p. 49. & 69.

(g) Diff. p. 60. *Ess.* p. 49.

“ Water

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“ Water is as strongly impregnated with the Virtues
 “ of the Lime as the first (a). In this case, however,
 “ as in many others, the Truth is wholly on neither
 “ Side: For although Quick-lime does communicate
 “ its Virtues to Water much longer than any one could
 “ have expected before making the Trial; yet it is
 “ *most certain*, that the Waters got off Quick-lime
 “ *became gradually weaker*; and that the first Water
 “ contains more of the Lime, and is stronger, more
 “ pungent and disagreeable to the Taste, than the
 “ 10th, 12th, or succeeding ones. The Discovery
 “ therefore, of which the Doctor claims the *Honour*,
 “ and indeed justly, comes out to be *partly real, and*
 “ *partly imaginary*. And the Reason why the Author
 “ of this Essay took no particular Notice of this Dis-
 “ covery in the former Edition, was the Aversion he
 “ had to criticise upon his good Friend, or to enter
 “ into a Controversy with him” (b).

33. Were I disposed to criticise, this Paragraph would afford both sufficient Subject and Apology for it. But I shall observe only, that as it would not be very proper to say that Borax continues long, or longer than Nitre, to communicate its Virtues to Water; so I neither claim the Discovery of Quick-lime's continuing to communicate its Virtues to Water much longer than any one expected, nor any where affirm, that the last Water is as strongly impregnated with the Virtues of the Lime as the first. For if one Part of Borax be infused in 30 Parts of Water, it will all dissolve in much less than one Day; but if in seven Parts only, (for 5, 50, or 500 Days, no matter which), the Water will be as strong as if three or four Parts only had been taken; and yet the remaining Borax continue to impregnate the same Quantity of Water a second, third, and fourth time, as strongly as the first; but if seven times its Weight of Water be added a fifth Time, it will be weaker than the first considerably. Just so, if

(a) Phil. Transf. vol. 47. p. 266. Diss. p. 4. 5. & 6.

(b) Note on Ess. p. 43.

as much Water be taken, as can dissolve or take up all the dissolvable Part of the Quick-lime, a few Days will exhaust it; but till such a Quantity of Water be employed, the Lime will not be exhausted, at least in seven Years Time. That the last Water is sometimes weaker than the first, is shewn, *Diff. p. 7. & 64.* And by the Directions given, *Diff. p. 29.* it is evident, that it was always my Opinion, that the second Water may be weaker than the first, yea and the first weaker than the second; which has often happened (*a*).

34. The Certainty of the Doctor's Affirmation will presently appear. In the mean time, the Taste affords but a weak Argument for it (*b*); especially since he says, "If cold Water be poured upon Shell-lime, very little Heat or Ebullition ensues: Yet the Lime-water thus procured seems to have as great a Power of dissolving the Stones, as when made with boiling Water; but is more harsh and disagreeable, the other having a softness and sweetness which this wants" (*c*). The soft and sweet, therefore, may be as strong as the harsh and disagreeable. And as Shells fully calcined cause as great Heat and Ebullition in cold Water as in hot; so I never could discover any Difference in the Taste of the Lime-water, whether made with hot or cold Water. Would the Doctor make Lime-water his common Drink for a few Days, the only Way to get a right Notion of its Taste, he would find it sometimes more pungent and disagreeable, sometimes more soft and sweet; and that whether it were of the first or of the twelfth Infusion. Again,

35. Since double Shell-lime Water loses an eighth Part of its Strength, by standing eight Days on the Lime (*d*); and Lime-water made in a Bottle of one Part Lime, and 600 Parts Water, after seven Days, is but a tenth Part weaker than the Lime-water made of one Part Lime, and eight or nine Parts Water (*e*),

(*a*) *Vid.* No. 38. *infra.*

(*b*) *Vid.* *Diff.* p. 32. & 62.

(*c*) *Ess.* p. 34.

(*d*) *Phys. Ess.* p. 378.

(*e*) *Ess.* p. 48. 50. & 59.

the Difference is inconsiderable. If the tenth Part of the Lime was Sand, it accounts for it fully; and supposing there was nothing uncalcined in it, had 540 Parts Water been taken instead of 600, this Bottle Lime-water must have been as strong as the common. Such a Decrease of Strength, supposing it were real, must have been altogether imperceptible by my Experiments (a); and to declare any Part of the Discovery *imaginary*, because I did not perceive what was imperceptible by the common Methods of Trial (b), discovers no great Aversion to criticise on a Friend, or to enter into a Controversy with him. In the first Edition of the *Essay*, p. 43. the Doctor observes, that "some Stone-lime, which had been reduced to a Powder, by being exposed to the open Air for four Months, still retained some of its Virtue, after having had, during the Course of 60 Days, 260 times its Weight of Water poured upon it; and some Lime-water procured from calcined Oyster-shells, upon which in 48 Days he had poured 270 times their Weight of Water, was, by Experiment, found to be possessed of a considerable Power of dissolving the Stone." Here I think particular Notice is taken of the Discovery, but none of the Discoverer; whom he might have mentioned, as I did him (c), (which was all the Honour I claimed); how great soever his Aversion to Criticism and Controversy might be, which by no means can excuse the concealing of any Truth which ought to be known. But,

36. Neither is this gradual, and to me imperceptible Decrease of Strength, at all proved by the Doctor's decisive Experiments, even though the Strength of Lime-water was always proportional to the Quantity of the Precipitation with Salt of Tartar; which most certainly it is not, as will presently appear. It is true, that, by the Doctor's Experiments, 12 Ounces and one Dram of Stone-lime Water of the first Infusion, mixed with

(a) *Vid. Diff. p. 57.*(b) *Vid. Diff. p. 5.*(c) *Diff. p. 2.*

30 Grains of Salt of Tartar, precipitated scarcely 10 Grains of white Powder. As much of the tenth Infusion, treated the same Way, gave $8\frac{1}{2}$ Grains, and of the seventeenth Infusion, $7\frac{1}{2}$ Grains of white Powder (a). But unless it appears also, that this Difference could be owing to nothing but the Number of Infusions, these Experiments prove nothing. For although the tenth and seventeenth Infusions seem to have remained a competent Time on the Lime, yet this is not enough. There are other Circumstances as necessary to the compleat Saturation of the Water, which seem to have been neglected. For,

37. I infused two Ounces of flaked Stone-lime, which I had kept dry nine Months, in five Gills of Water. After two Days, I filtered through gray Paper (which is always to be understood when I mention Filtration) three Gills, or 12 Ounces and one Drop, *Avoirdupois* Weight, of this Lime-water; dissolved in it 30 Grains of Salt of Tartar; and from the Solution, by Filtration, got 10 Grains of dry white Powder. Three Gills of Lime-water, made of one Part of the same Lime, when seven Months old, and twelve Parts Water, and after it had afforded above 100 times its Weight of Lime-water, treated the same Way, gave just 10 Grains of white Powder also. See likewise N° 44. 45. 46. below. So here no gradual Decrease of white Powder. There must therefore have been some Defect or Mistake in the Doctor's Experiments, or in mine; and I wish some third Person would repeat them, with sufficient Accuracy, to discover where it lies. In order to which, it ought to be carefully observed,

38. *imo*, That, seeing right Lime-water, though filtered, exposed to the Air, in about a Day's Time is covered with a white brittle Crust; unless the first, as well as succeeding Infusions of Quick-lime, in open Vessels, be so crusted before they are filtered, we cannot be sure that they are fully impregnated, how long soever they have stood on the Lime. Hence the Di-

(a) *Vid. Ess. p. 48. & 49.*

rections commonly given for the Preparation of Lime-water, being founded on a Mistake as to the Manner of Quick-lime's communicating Virtues to Water, (as if it were done at once by a kind of Explosion on the Lime's growing hot, and falling down), are commonly very defective and imperfect, excepting those of *Ans. Boëtius de Boas (a)*. But,

2^{do}, That, since such Parts only of the Water as come in Contact with the Quick-lime, can act upon it, the full Saturation of the Water depends no less on its being sufficiently agitated and mixed with the Lime, than on the Time allowed: For I found, that Lime-water, of one Part Shells, and but six Parts Water, after more than four Days Maceration, but unmoved, did not yield half so much Crust, as it did the Day after it was well stirred. Yea, Stone Quick-lime, though it turn hot and fall in Water, may lie several Days in it, and yet the upper Part of it be tasteless. Hence the Time the Water has remained on the Lime, is no Evidence, by itself, of its having dissolved as much of it as it can take up. And,

3^{tio}, That, because Lime-water becomes weaker in proportion to the Crusts thrown up, when the Water stands long on the Lime, especially if it bears but a small Proportion to the Water, the upper Part of the Lime-water, to which the Air has Access, must be weaker than the lower Part, unless it be well mixed with the Lime, and suffered to subside only for a short Time before it is filtered, or filtered while turbid; and consequently, although all the Water should be poured off, it will not be so strong, as it would have been had it been properly moved. Hence the 10th, yea 50th Lime-water, may really be stronger than the first, as well as the first stronger than any of the succeeding ones. And we see how the Doctor's Experiments may be accounted for; and that they do not make it *most certain*, that the Waters got off Quick-lime necessarily must grow gradually weaker. And that this is the true

(a) *Vid. Diff. p. 29.*

Account, the Experiments themselves seem to confirm.
For,

39. If the Lime-waters necessarily became gradually weaker, their Decrease of Strength would be *either* in proportion to the Number of Infusions; that is, the seventh Water would be as much weaker than the fourth, as the fourth is weaker than the first; or, *rather*, it would be greater after many than after few Infusions; that is, the eighth Water would not be so much weaker than the first, as the fifteenth is weaker than the eighth. But neither of these Ways do the Waters got off Quick-lime become gradually weaker, by the Doctor's Experiments; the sixth Shell-lime Water being as much weaker than the first, as the seventeenth is weaker than the sixth; the first Shell-lime Water affording 13, the sixth 10, and the seventeenth 7 Grains of white Powder (*a*). Again,

40. It deserves also to be observed, that the same Salt of Tartar and Lime-water, mixed in the same Proportion, may yield sometimes more, sometimes less white Powder. Thus 30 Grains of Salt of Tartar, dissolved in three Gills of Lime-water, and filtered immediately after the Solution of the Salt, gave 10 Grains of white Powder; whereas the same Quantities of the same Lime-water and Salt mixed, but not filtered till next Morning, gave scarcely eight Grains of this Powder. And, to say nothing of the Degree of Exsiccation, I might add, that the very Quantity or Largeness of the filtering Papers, when weighed together with the Powders, and their Texture, when the Powders are weighed separately, may make the Quantity of the Precipitation appear to be greater or less than it really is; the one retaining more of the Salt, the other more of the Powder. So precarious are the Arguments drawn from these Experiments, for the different Strengths of Lime-waters. I weighed always first the dried Papers with the Powders in them, and then the Powders by themselves; but I give the Weight

(b) *Vid. Ess. p. 47. 48. 49.*

of the Powders, as I found it, when separated from the Papers carefully.

“The above Lime-waters,” says the Doctor, “were all made in glazed earthen Vessels, the Mouths of which were not covered; this being the common Way of making Lime-water, and that which both Dr *Alston* (a) and I generally observed. But *that I might know* what Difference would be produced in the Strength of the Water, by infusing the Lime in a close Vessel,—I put into a Glass Bottle three Ounces of Stone-lime, with 27 Ounces of Water. After an Infusion of seven Days, (shaking it, however, once every Day), 12 Ounces and one Dram of this Water, mixed with 30 Grains of Salt of Tartar, afforded 11½ Grains of white Powder.——The same Quantity of the 18th Infusion, in a close stopped Bottle, of the Stone-lime, afforded 9½ Grains of white Powder. I infused 20 Grains of Stone-lime in 25 Ounces, or 600 times its Weight of Water, in a corked Bottle, for seven Days. After which, 12 Ounces and one Dram of the Water, filtered, and mixed with 30 Grains of Salt of Tartar, gave near nine Grains of white Powder” (b).

41. It is no where said in the *Dissertation*, that I generally make Lime-water in uncovered earthen Vessels. I generally indeed make it in glazed earthen Vessels; but I have often made it also, both in open and close Timber Vessels, as well as in a close stopped Bottle; but always so covered, as to keep out Insects and Dust, excepting the Bell Glass (c), which being designed for watering the Earth, needed not a Covering. Here the Doctor speaks of making Lime-water in a Bottle, as if it had never been thought of before; though he cannot but remember, that I recommended that Experiment to him as a decisive one long before he made it (d). But

Since, by the Doctor's Experiment, less than the

(a) *Diff.* p. 4. 5. 6. & 7.

(b) *Vid.* *Ess.* p. 49. 50.

(c) *Diff.* p. 4. & 5.

(d) *Vid.* *Diff.* p. 60.

half of 25 Ounces of the Lime-water made of 20 Grains of Stone-lime, gave near nine Grains of white Powder, the whole 25 Ounces would have given 18 Grains; while more than 12 Grains of the Lime must have remained in the Filtre. All the white Powder, therefore, could not come from the Lime in the Water. If it be said, that it came from the Crusts; I allow it. But then it must follow, (as is observed, *Diff.* p. 8. 9.), that the Quantity of the Crusts considerably exceeds the Quantity of Lime contained in the Water; and consequently the white Powder is improperly said to be "no other than the calcarious Matter which was "before contained in the Water" (a). Besides,

42. Since 12 Ounces of the Bottle Lime-water, made of one Part Lime, and 600 Parts Water, is but a tenth Part weaker, or yields but a tenth Part, or one Grain, less of white Powder, than the same Quantity of Lime-water made of one Part Lime, and (nine we shall call it) 10 Parts Water; if for one Part Lime, 300 Parts Water had been taken, the Difference would have been one half less, or half a Grain of white Powder. So if 100 Parts Water only had been used, 12 Ounces and one Dram of this Lime-water, mixed with 30 Grains of Salt of Tartar, ought to have afforded 10 Grains of white Powder; wanting the sixth Part of a Grain; that is, the Difference imperceptible betwixt the first and tenth Infusion, though it is made $1\frac{1}{2}$ Grains, *Ess.* p. 48. (2.). Again,

Suppose the $12\frac{1}{2}$ Ounces of Bottle Lime-water, of one Part Lime, and 10 Parts Water, affords 12 Grains white Powder, but of one Part Lime, and 600 Parts Water, nine Grains; the Difference is three Grains. If therefore 300 Parts Water had been taken in place of 600, the Differencee would be $1\frac{1}{2}$ Grains; and if 100, half a Grain. But the 100 Parts Water being equal to the tenth Infusion, of it therefore 12 Ounces and a Dram, with 30 Grains of Salt of Tartar, should precipitate $11\frac{1}{2}$ Grains of white Powder; though, by

(a) *Ess.* p. 88.

Eff. p. 50. (3.), the eighteenth Infusion yields only $9\frac{1}{2}$ Grains. Are these consistent?

43. But that Lime-water should be any stronger when made in a Bottle, than when made in an open Vessel, without any other Cause of the Difference, cannot easily be admitted. For since the Air *actionem corporis unius in aliud determinat applicatque* (a), it can never diminish the Power of any *Menstruum*, but must increase it. That Water therefore dissolves more Lime in a close corked Bottle than in an open Vessel, is one of those stubborn Propositions which will not be proved, though never so much Pains be taken to do it. If indeed the Water in the Bottle be well moved, while that in the open Vessel is not, there may be a great Difference of Strength (b); and "the Addition of
" fresh Lime to the one will not make near so great a
" Difference of Strength in it, as it will do when added
" to the other" (c); because the adding fresh Lime puts the Water in Motion, and so promotes its Impregnation; but otherwise useless, if there be Lime enough in it already: Whereas the Lime-water made in a Bottle, being fully saturated, and losing none of its Lime by Crusts, admits of no Addition. It remains then only to be inquired, whether the Lime-water made of one Part Lime, and nine Parts Water, mixed with Salt of Tartar, affords more white Powder than the Lime-water made of one Part Lime, and 5 or 600 Parts of Water, how accurately soever it be prepared? which Experiments alone can determine. Wherefore,

44. I infused two Drams of slaked Stone-lime, more than eight Months old, in 17 Gills, or above 253 times its Weight of Water, in a wide-mouthed Stone Can, and covered it, but not so as to keep out the Air. After 14 Days, I filtered three Gills of this Lime-water, dissolved in it 30 Grains of Salt of Tartar, and by Filtration, &c. got from it 10 Grains of dry white Powder. Now, considering the Age of the

(a) B. Chem. 1. p. 538.

(c) *Vid.* *Eff.* p. 54.

(b) *Vid.* No. 38.

Lime (a), and the Water wherewith it was slaked, to say nothing of what it might have since imbibed from the Air, nor of the Crusts thrown up in 14 Days, the two Drams cannot be reckoned much stronger, than one Dram of recent Quick-lime: Yet they afforded as much white Powder, as the Doctor's Lime-water of the first Infusion, of one Part Lime and nine Parts Water (b). Again,

45. I sifted with a fine Hair Sieve, some of the same old flaked Stone-lime; put four Drams of it into the Stone Can, and as much into a Glass Bottle, adding to each 13 Gills of Water, and shaking both several times that Day. Next Day I filtered, and mixed 30 Grains of Salt of Tartar with three Gills of each, which gave 10 Grains of white Powder; the Can Lime-water affording rather more than the Bottle. After 10 Days, I repeated the Experiment on both these Lime-waters, and had exactly the same Quantity of white Powder from each.

I found also, that one Dram of the flaked Stone-Lime, when above nine Months old, made 13 Gills, or 387 times its Weight of Water, so strong in seven Days Infusion, in a corked Bottle, that three Gills of it, mixed with 30 Grains of Salt of Tartar, precipitated nine Grains of white Powder; that 20 Grains of this Salt of Tartar, dissolved in three Gills of this same Lime-water, gave only $7\frac{1}{2}$ Grains of the white Powder; and that there remained of the Lime 35 Grains. So there were 25 Grains dissolved; which is a fifth Part more than I had formerly observed, probably because the Lime was sifted. Hence Lime-water of one Part Lime, and 5 or 600 Parts Water, may yield as much white Powder, as when made of one Part Lime, and 10 Parts Water. And, in confirmation of N^o 43.

46. I divided 560 Grains of recent Oyster-shell Quick-lime into two equal Parts; put one half into the Can, and the other into the Bottle; and poured into each two Gills of cold Water; which made the

(a) *Vid.* *Ess.* p. 28. & 36.

(b) *Ess.* p. 48.

Shells, with Noise and Heat, split in Pieces, and fall for the most part into Lime. After frequently shaking them, during 44 Hours Maceration, I filtered a Gill and an half of each of these Lime-waters, (which were most disagreeably empyreumatic); dissolved in it 15 Grains of Salt of Tartar, and by Filtration, &c. got eight Grains of white Powder; from the Can Mixture fully as much as from the other, without any Difference. From these Experiments, as well as from the Reasoning N^o 43. I think may be inferred, that Lime-water prepared in an open Vessel, precipitates as much white Powder, with Salt of Tartar, as when prepared in a corked Bottle, if the Preparation be not otherwise defective.

47. It is true, that, according to this last Experiment, three Gills of Shell-lime Water, with 30 Grains of Salt of Tartar, precipitated 16 Grains of white Powder; which is considerably more than any Stone-lime Water afforded. It is true also, that when the Bottle was emptied into the Can, and 11 Gills of Water added; after it stood several Weeks, three Gills of this still empyreumatic Water, with 30 Grains of Salt of Tartar, gave 12 Grains of white Powder. But since Shell-lime Water yields no more Crusts than Stone-lime Water, though both are equally effete when all the Crusts are separated; this white Powder must be owing, in Part, to the heterogeneous Substances, and prove that, at least, some Shell-lime Waters abound more with them than Stone-lime Water: Which the Doctor's Experiments also seem to confirm.

For he found, that eight Ounces and two Drams of double Shell-lime Water, which had stood 24 Hours on the Lime, mixed with 20 Grains of Salt of Tartar, gave eight Grains of white Powder; but when the Water remained eight Days on the Lime, the same Mixture afforded only about seven Grains (*a*). And "it is observable," says he, "that double Shell-lime Water, notwithstanding it remains on the Shells,

(*a*) *Phys. Ess.* p. 378.

“ loses in a few Days Part of its Pungency and Strength ;
 “ while the weaker Lime-waters seem to be constantly
 “ supplied with fresh Virtue from the Shells, sufficient
 “ to make up what they lose by the Contact of the
 “ Air” (a): Which can be ascribed to nothing, but
 to the Lime’s throwing down some of the heterogeneous
 Substances the Water had taken up; especially
 since the Doctor’s Lime-water exposed to the Air began
 very soon to let fall some Sediment, of the same Nature
 with the Scum it throws up (b), which Stone-lime
 Water never does. And because these Lime-waters
 which gave so much white Powder, were both strongly
 empyreumatic, perhaps Part of the Powder was owing
 to the same Cause with the *Empyreuma*.

48. Although, therefore, the Doctor affirms, that
 “ the Quantity of calcarious Powder, precipitated upon
 “ mixing Lime-water and Salt of Tartar, *must be* in
 “ proportion to the Strength of the Lime-water, whe-
 “ ther this Powder be supposed to arise from the Salt,
 “ or from the Water, or from both, it *must follow*
 “ from the above Experiments, *imo*, That Quick-lime
 “ communicates more of its Virtues to Water at first,
 “ than afterwards,” &c. (c); yet, since the same
 Lime-water does not always afford the same Quantity
 of calcarious Powder (d), since the Powder in Part
 may be owing to heterogeneous Substances (e), and
 since the Strength of Lime-water depends chiefly on the
 Manner of preparing it (f), Quick-lime may commu-
 nicate as much of its Virtues afterwards, yea more than
 at first; and consequently his Inferences do not follow.
 I shall mention only the fourth, *viz.*

“ It is so far from being true, as Dr *Alston* ima-
 “ gines (g), that Lime, as long as it *retains any Virtue*,
 “ will impregnate Water with as much of its finer
 “ Part as it can receive, that Quick-lime does not
 “ give, even to the first Water, when made in an open

(a) *Ess.* p. 42.

(b) *Ess.* p. 76.

(c) *Ess.* p. 51.

(d) *Vid.* No. 38.

(e) *Vid.* No. 25. & 47.

(f) *Vid.* No. 38.

(g) *Diff.* p. 57.

" Vessel, so much of this as the Water can take ; since
 " the Water can be rendered sensibly stronger, by making it in a close stopped Bottle" (a).

49. I never imagined, that Lime, as long as it retains any *Virtue*, &c. For the Words of the *Dissertation*, p. 57. are: " To me it appears more probable, that Water can bear or dissolve only a certain Quantity of Quick-lime ; and if there be as much Quick-lime in it as will afford this Quantity, and sufficient Time allowed, it will impregnate itself so fully as to be able to bear no more." And, if duly mixed, this I imagine still to be not only probable, but a certain Truth ; whether the Lime-water be made in a Bottle, or in an open Vessel, being the Property of every *Menstruum*, as well as evinced by a Variety of Experiments carefully executed (b). And I imagine also, that,

Since " Lime-water becomes effete, as soon as it loses its earthy Matter" (c), and consequently is weakened in proportion to the Crusts thrown up, its Strength must be proportional to the Quantity of Crust it can yield, whether there be in it heterogeneous Substances to increase the Quantity of white Powder or not. And since the first Lime-water yields not more Crusts than the succeeding ones ; Bottle Lime-water no more than Can Lime-water ; while the Quantity of the Crusts exceeds the Quantity of the dissolved Lime (d) ; it must follow, (from *Diff.* p. 8. & 60. and N° 44. &c.), that Quick-lime communicates no more of its Virtues to Water at first than afterwards ; and that Lime-water may be made as strong in an open Vessel as in a close stopped Bottle, though not quite in so large a Quantity For,

By making Lime-water in a Bottle, the Formation of Crusts, and the consequent weakening of the Water, is prevented. So it must be the surest, as well as easiest Way, to determine accurately how many Parts

(a) Eff. p. 53.

(c) Eff. p. 76. 171.

(b) Vid. No. 40. 45. 46.

(d) No. 41.

of Water one Part of Quick-lime can impregnate; and preferable to repeated Affusions of Water, in an open Vessel, with such Intervals of Time as are necessary to its Saturation (*a*); whereby much of the Lime must be thrown up in Crufts, and the Quantity or Strength of the Lime-water diminished.

S E C T. IV.

50. The next Inquiry is, Whether the Powder precipitated by mixing Salt of Tartar and Lime-water, is no other than the calcarious Earth which was before contained in the Water? By my Experiments, it appeared to be chiefly from the Salt; but at the same time I observed, that "the precipitating Quality of Lime and Lime-water, and their Action on alkaline Salts, deserved to be further prosecuted than I had Time for then" (*b*). This I have since attempted; and I hope acceptably to my Friend Dr *Whytt*, who thus explains himself on this Head.

"I had said (*c*), that the Precipitation which happens upon mixing Salt of Tartar with Lime-water, is almost wholly from the Water, and not from the Salt. This has occasioned some Remarks by Dr *Alston* (*d*); who having, in the first Edition of his Dissertation on Quick-lime, affirmed, that this Precipitation was chiefly from the alkaline Salt, thought himself obliged, it would seem, to overthrow a Position so inconsistent with his own. But that it may appear, what Ground the Doctor had for attacking me on this Quarter, I shall shortly produce my Reasons for thinking, that the Powder precipitated by mixing Salt of Tartar with Lime-water, is no other than the calcarious Earth which was before contained in the Water. *imo*, The calcarious Matter precipitated by mixing Salt of Tartar and Lime-water,

(*a*) Eff. p. 48. & 49.

(*b*) Diff. p. 22.

(*c*) Phys. Eff. p. 379.

(*d*) Diff. p. 64.

" is in proportion to the Quantity and Strength of the
 " Lime-water, but not of the Salt," &c. (a).

51. Having observed, that Lime-water precipitated something from, and clarified almost every Vegetable Infusion, Wine, Animal Fluid, as Bile, Urine (b), &c.; as also, that two or three Drops of Lime-water falling into a Solution of Potash, turn white at first, but soon disappear; while two or three Drops of that Solution falling on Lime-water, not only grow white at first, but continue so, falling to the Bottom in Form of a white Powder (c); which Precipitation being evidently heavier than the Lime in the Water, I thought it " more than probable, that the Precipitation was " chiefly from the fixed alkaline Salt;" especially seeing a Spoonful of a weak Solution of Potash, mixed with three Spoonfuls of Lime-water, precipitated three Grains of white Powder; which is more than double the Quantity of the Lime contained in that Water (d).

52. But, on the other hand, the Doctor having found, that 12 Grains of Salt of Tartar, mixed with four Ounces of strong Lime-water, yielded as much calcarious Matter, as when 18 Grains of the Salt are mixed with it (e), thence concluded, that the Powder precipitated proceeds wholly, or almost wholly, from the Water; adding, " These Experiments shew, " beyond Doubt, that double Lime-water may contain thrice as much Lime, as Lime-water made by " pouring on Quick-lime 512 times its Weight of Water (f). All which is sufficiently answered, *Diff.* p. 64. & 72.; and the contrary, as I thought, made evident to the Sight, as by dropping a Solution of Potash into Lime-water, so by mixing together equal Quantities of these two Liquors. For,

53. When equal Quantities of a Solution of Potash, not very weak, and Lime-water, are mixed in a Glass, their Colour and Transparency are little altered, no

(a) *Ess.* p. 88. Note *.

(d) *Vid. Diff.* p. 19. 20.

(b) *Vid. Ess.* p. 30.

(e) *Vid. Note on Phys. Ess.* p. 379.

(c) *Vid. Diff.* p. 10. & 20.

(f) *Phys. Ess.* p. 379.

Precipitation

Precipitation follows, no Crusts are thrown up. The alkaline Salt, therefore, here separates none of the calcareous Matter of the Lime-water, but is quietly united to it in its dissolved State. But to demonstrate more fully the Weakness of the Doctor's first Reason, and that it may appear what Ground I had for attacking my Friend on this Quarter, I shall relate a few easy Experiments.

54. Having mixed 30 Grains of Salt of Tartar with three Gills of several Sorts of Lime-water many times, and reserved the filtered Liquors in different Bottles, which I call tartarised Lime-waters;

1^{mo}, I mixed two Gills of tartarised Shell-lime Water with as much plain Shell-lime Water; next Day filtered the Mixture, and got no more than three Grains of white Powder; though, according to the Doctor, there must have been 20, or near 20 Grains of the Salt, and five or six Grains of the Lime in the Mixture. Again, to two Gills of this last filtered Liquor, I added two Gills of plain Shell-lime Water. Here was, according to him, near 10 Grains of Salt of Tartar, and about nine Grains of Lime: Yet no Precipitation followed, the Mixture continuing as clear as Fountain-water. Here the Precipitation is neither in proportion to the Quantity nor to the Strength of the Lime-water. This led me to think, that if only five Grains of Salt of Tartar were dissolved in two Gills of Lime-water, the precipitating Power of either would be quite spent. Accordingly,

2^{do}, I mixed five Grains of this Salt with two Gills of Shell-lime Water; next Day filtered, and got $2\frac{1}{2}$ Grains of white Powder: And having mixed one Gill of this filtered Liquor with as much Shell-lime Water, no Precipitation happened, the Mixture continuing as clear as filtered Lime-water. Nor did the Addition of another Gill of Lime-water make any Alteration; but one Grain of Salt of Tartar put into it, turned it instantly white and turbid. And is it not hence probable, that the Lime-water precipitates somewhat from the

the Salt, since increasing the Salt increases the Precipitation? But,

55. 3^{do}, I dissolved in half a Gill of Shell-lime Water 258 Grains of the common Salt of Tartar of the Shops, and got from it by Filtration 56 Grains of white Powder. To this Solution I added another Half-gill of the Lime-water, which afforded 11½ Grains of white Powder, though half a Gill of Lime-water contains not two Grains of Lime. The same Quantity of true Salt of Tartar, which Dr Black prepared, and gave me, (wherewith all the above Experiments were made, except the preceding one), treated the same Way, yielded on the first Filtration 23 Grains, and on the second 12 Grains of white Powder. Here also the Precipitation must be chiefly from the Salt, and not from the Lime-water (a). Again,

56. 4th, Having dissolved 30 Grains of Salt of Tartar in three Gills of Shell-lime Water, and by Filtration got 12 Grains of white Powder, I then dissolved the same Quantity of the Salt in two Gills of the same Lime-water, which afforded by Filtration only eight Grains of the white Powder; which is the only one of a great many Experiments that I made with Salt of Tartar which favours the Doctor's Assertion. But when I mixed 30 Grains of the Salt with four Gills of the same Lime-water, I got no more than 12 Grains of white Powder; the same Quantity which three Gills afforded; which again directly opposes it. The Proportion therefore which gives the greatest Precipitation, so far as I have observed, is 30 Grains of Salt of Tartar to three Gills of Lime-water, or 10 Grains to the Gill. From these Experiments, I think, may be inferred also,

57. 1^{mo}, That when the Quantity of the fixed Salt, and of the Lime in the Water, are nearly equal, increasing the Quantity of the Lime-water does not increase the Quantity of the white Powder. 2^{do}, That increasing the Quantity of the Salt, more often increases the

(a) Vid. No. 40.

Precipitation,

Precipitation, than increasing the Quantity of the Water. 3^{to}, That when the Lime in the Water, bears but a small Proportion to the *Alkali*, it is absorbed by it, or so united to it, as to continue in a dissolved State, with little or no Precipitation on either Side. But when it bears a much greater Proportion to the *Alkali*, the Precipitation is more considerable on both Sides, and various according to the Proportion in which they are mixed, but generally, if not always, greater of the *Alkali* than of the Lime. And therefore, 4^{to}, That it cannot be affirmed in general, that the Precipitation, or calcarious Matter, as the Doctor calls it, is no other than the calcarious Earth of the Lime-water; or is in proportion to the Quantity and Strength of the Lime-water, but not of the Salt. And,

58. Since these Experiments, as well as those N^o 17. 18. 19. & 22. above, demonstrate, that the Precipitation by Salt of Tartar is, often at least, chiefly from the Salt, I need take no Notice of the other Reasons advanced against a certain Fact; nor am I concerned to account for them. I cannot however but observe, 1^{mo}, That the second Reason is easily answered by what has been said on the first, and in *Diff.* p. 64. Besides, on mixing Sope-ley and Lime-water, the *Phænomena* are the same with those N^o 53. 2^{do}, The third Reason is accounted for by the Effect of alkaline Salts on Quick-lime (a): For if the Precipitation were always from the Lime-water, there ought to have been a Precipitation here, there being Lime enough to impregnate the Water. But the Solution of the Salt extracting no more from the Shell than it kept in a dissolved State, and fixing the rest, there could be no Precipitation. The fourth Reason falls with the first. But the fifth demands a more particular Answer.

“When two or three Drops of Lime-water,” says the Doctor, “fall into a Solution of Potash, they become immediately white; but this Appearance soon after vanishes, because so small a Quantity of Lime-

(a) *Vid.* *Ess.* p. 93. *Macquer. elem.* p. 62. and below, No. 69.

“ water affords too little earthy Matter to be visible,
 “ when disperfed through the whole Solution of the
 “ Salt. If an Ounce of Lime-water mixed with Salt
 “ of Tartar, gives only a Grain of calcarious Matter,
 “ one Drop will not give $\frac{1}{300}$ Part of a Grain, which
 “ is too fmall to be vifible, when it falls to the
 “ Bottom of the Glafs in the Form of a Powder.
 “ But, on the other hand, a few Drops of a Solution
 “ of Potafh let fall into a Glafs of Lime-water, ren-
 “ der the whole turbid and milky, and precipitate a
 “ white Powder; becaufe a very little of the Solution
 “ is fufficient to feparate a confiderable Quantity of
 “ calcarious Matter from the Water. Thefe Experi-
 “ ments, therefore, are fo far from fhewing, that the
 “ Precipitation in queftion is chiefly from the alkaline
 “ Salt (a), that, when viewed in a juft Light, they
 “ clearly demonftrate the contrary; and thus over-
 “ throw the Opinion they were adduced to con-
 “ firm” (b).

59. If the Whitenefs of the Drops of Lime-water
 on the Solution of Potafh difappeared gradually in dif-
 perfing through the Solution, as they fall down, there
 might be fome Reafon for the Doctor’s Remark. But
 nothing falls down. The Whitenefs vanifhes on the
 Surface of the Solution, and is as vifibly diffolved, or
 abforbed into it, as poffibly any fuch Thing can be;
 and the Appearance is the fame, though 500 Drops of
 Lime-water are ufed the fame Way. Befides, if the
 Solution be tolerably ftrong, no Whitenefs at all ap-
 pears, even on the Surface, though hundreds of Drops
 of Lime-water are put upon it. And by the Experi-
 ments N^o 54. &c. it appears, that a very little of the
 Solution is not fufficient to feparate a confiderable
 Quantity of calcarious Matter from Lime-water. Thefe
 Experiments, therefore, are fo far from overthrowing
 the Opinion they were adduced to confirm, that, when
 viewed in a juft Light, they clearly demonftrate, that

(a) Diff. p. 20.

(b) Eff. p. 90. Note 5.

the Precipitation in question is very different from the calcarious Earth of Lime-water.

60. As in many, if not in all Precipitations, Part of the *Præcipitans* adheres to the *Præcipitatum*, and, in order to a compleat Precipitation, the Precipitant must bear a certain Proportion to the Solution, that is, to the *Menstruum*, as well as to the Substance dissolved in it; so the Conditions, no less than the Causes of Precipitation, are often very obscure. For though by increasing the *Præcipitans*, the *Præcipitatum* is commonly increased; yet it has sometimes a very different Effect. For Instance,

To make Oil of Vitriol dissolve Iron successfully, it must be diluted with a quadruple Quantity of Water (*a*); and to precipitate such a Solution, only a small Quantity of an *Alkali* must be added: for if a large Quantity be thrown into it at once, no Precipitation follows, the Liquor continuing clear and transparent; or if at first it appears muddy, in a Moment it recovers its Pellucidity, and the Precipitant becomes a Solvent (*b*). Although it were granted, therefore, that 30 Grains of Salt of Tartar precipitated all the Lime in 12 Ounces of Lime-water, which most certainly it does not; yet it by no means could be thence inferred, that a much greater Proportion of the Salt will prove a Precipitant also, or support the Doctor's Constitution of Sope-ley. Which brings me to inquire, whether Quick-lime communicates to Water any thing but the calcarious Matter which it throws up in Crusts?

S E C T. V.

" Since the Difference," says Dr *Whytt*, " between
" the specific Gravities of Lime-water and common
" Water, is considerably more than the Weight of the
" Crusts which the former throws up, or of the cal-
" carious Powder which it precipitates, by being mix-
" ed with Salt of Tartar; it is probable, that Quick-

(*a*) *Phys. Ess.* p. 293.

(*b*) *Vid. Macq. Elem.* p. 116.

“lime communicates to Water something besides this
 “earthy Matter. But of this we are fully convinced,
 “by observing, that after 12 Ounces of double Lime-
 “water had, by being mixed with 30 Grains of Salt
 “of Tartar, precipitated near 16 Grains of earthy
 “Powder, it tasted almost as strong of the Lime as be-
 “fore its Mixture with the alkaline Salt: Yet, by
 “adding more Salt of Tartar to it, I found that it
 “did not contain above one Grain more of the earthy
 “Part of Lime. Now, since the calcarious Matter of
 “Lime-water is perfectly insipid, and void of any o-
 “ther Virtue than what all absorbent Earths possess,
 “it follows, that not only the peculiar Taste of
 “Lime-water, but also its most conspicuous Virtues,
 “particularly that of dissolving the Stone, are owing
 “to some *subtile active Principle*, which is strongly at-
 “tracted by alkaline Salts, and thus separated from
 “the calcarious Matter with which it was before
 “closely united” (a).

61. Although the Doctor pretends not to determine,
 whether the active Properties of Quick-lime are owing
 to the Element of Fire closely united with, and, as it
 were, concentrated in its earthy Matter; or whether
 they are not rather to be ascribed to some new Change
 made on this Matter by the Action of the Fire (b):
 yet it is plain, that he determines in favour of the Ele-
 ment of Fire; and must do so, or give up his *subtile*
active Principle. But what appears to me to be more
 strange, is, that he should be convinced of the Existence
 of this *Principle* by such Arguments. For,

Since the Difference between the specific Gravities of
 Lime-water and common Water, is *considerably more*
 than the Weight of the Crufts which Lime-water throws
 up, or of the calcarious Powder which it precipitates,
 by being mixed with Salt of Tartar; nay more, I add,
 than the calcarious Substance remaining after Evapora-

(a) Ess. p. 95. 96. See Diss. p. 51. 62. 66. 71. 72.

(b) Ess. p. 94.

tion (*a*), and yet much more than there is Lime dissolved in the Water (*b*): is it not to a Demonstration certain, that the specific Gravity of Lime-water is wrong stated (*c*)? And that all the Lime is not precipitated by mixing Salt of Tartar with Lime-water, any one may be convinced by N^o 22. 57. &c.; yea and by observing, "that Lime-waters retain the Taste of the Lime after being mixed with the Salt of Tartar, and this equally after Precipitation as before it" (*d*), though quite insipid after all the Crusts are thrown up. Again,

62. The Particles of Fire, received into Lime-stone and Shells, while they are calcining, and remaining there, as it were, fixed and unactive, till they are set loose, by the Dissolution of the Parts of the Lime, by the Affusion of Water (*e*), cannot, in their fixed and unactive State, be an active Principle; and so soon as they are set loose, must dissipate, unless retained by an inflammable Substance, which alkaline Salts are not, far less Water. What becomes of the active Principle, when the calcarious Matter is turned into Crusts?

"It either soon flies off, or is destroyed" (*f*). "It is lost, or changed in its Nature by Exposition to the Air" (*g*). But how can it fly off, or be lost? It is not volatile, since a calcining Fire can neither drive it away nor destroy it (*h*). A Bottle can retain all the Virtues of Lime-water a long Time (*i*); and yet the active Principle is weakened by Distillation in close Vessels (*k*). And if it flies off at any Time, it must be when the Quick-lime is flaked and grows hot; the fixed unactive Particles of Fire being then set loose, by the Dissolution of the Parts of the Lime upon the Affusion of Water. But "the Vapour that arises from hot Water, during its Ebullition with Quick-

(*a*) *Vid.* *Ess.* 1st edit. p. 66. and *Diff.* p. 51. 52.

(*b*) *Vid.* *Diff.* p. 7.—10.

(*c*) *Ess.* p. 40.

(*d*) *Phys.* *Ess.* p. 379.

(*e*) *Ess.* p. 95.

(*f*) *Ess.* p. 84.

(*g*) *Ess.* p. 96.

(*h*) *Vid.* *Macquer.* *Chym. Prat.* 2.

p. 448. &c.

(*i*) *Ess.* p. 76.

(*k*) *Ess.* p. 75.

"lime,

“lime, is only an insipid inodorous Water, quite
“destitute of any of the Virtues of Quick-lime” (a).
Hence

The active Principle of Lime-water can be nothing
but the Lime dissolved in it; which being exposed to
the Air, by the Coalescence of its Particles, loses its
Subtilty, and becomes Crusts. To this, in its subtile
and dissolved State, the Taste, &c. of Lime-water are
owing, not to Particles of Fire, either fixed or set loose.
For that Lime-water tastes of the Element of Fire, I
believe no body can affirm. It is added in the *Essay*,

“Since alkaline Salts, while they unite with the
“more subtile Part of Lime-water, quickly precipitate
“its earthy Matter; is it not highly probable, that
“a Solution of these Salts poured on Quick-lime, will
“strongly attract and unite with its more subtile Part,
“but refuse to take up any, or almost any, of its pro-
“per terrestrious Matter? And is not this confirmed
“by Dr *Alston*’s Experiments, which shew, that Quick-
“lime, upon which a Solution of Potash was poured,
“instead of losing, acquired an Addition of Weight”
(b)?

63. How Quick-lime should acquire an Addition of
Weight, by a Solution of Potash’s strongly attracting
from it, its more subtile Part, on which its own Weight
considerably depends (c), is above my Comprehension.
For, in my Judgment, the Experiments referred to ra-
ther confirm, that Quick-lime attracts from the fixed
alkaline Salt. But since the Doctor makes so good Use
of my Experiments, I shall relate another of the same
kind, more compleatly executed, and of some Conse-
quence in the present Question.

64. I put an Ounce of slaked Stone-lime, near eight
Months old, into two Gills of a Solution of Potash,
weighing nine Ounces and a Dram, or 4380 Grains,
mixing them well several times that Day. Next Day
I filtered all I could pour off clear; which wanting a

(a) *Ess.* p. 75. 76.

(b) *Ess.* p. 96. 97.

(c) See also *Ess.* p. 84.

little of a Gill, I filled up the Measure with Sope-ley which I had by me; and it weighed four Ounces three Drums and an half; so wanted 60 Grains of the Weight of a Gill of the Solution taken.

65. The remaining Lime I diluted with two Gills of fresh Water, taking care always to mix them well. After compleat Subsidence, I filtered through the same Paper a Gill of this Liquor, which weighed three Ounces seven Drums and six Grains; so four Drums 24 Grains lighter than the former, and about two Drums 10 Grains heavier than a Gill of Fountain-water: So there might be of Salt among the Lime about four Drums and 20 Grains; to which I added two Gills more of Water, and filtered off as much, which might contain about two Drums and 20 Grains of Salt. I repeated the same Addition a third Time, filtering two Gills as formerly; which therefore could not contain above 76 Grains, perhaps not 60, of Salt, in about 3576 Grains of Water: Yet when I attempted to taste it, it burnt the Lips and Tip of the Tongue like a Caustic, raising a painful Inflammation which neither Brandy nor Oil could that Day overcome; and though they prevented blistering, yet in a Day or two the Cuticle of the Lips separated. And,

66. Having conveyed all the Lime into the filtering Paper, I washed it well, pouring on it fresh Water, till a full *English* Quart had passed through it, and was become quite insipid; then, turning it out of the Paper into a Crucible, I kept it on the Fire till it became red-hot, and so freed, at least, of some of the Water wherewith it was slaked, as well as of all that was added since: Yet it weighed 10 Drums and 10 Grains; that is, was two Drums and 10 Grains heavier than when put into the Solution; whence it must have attracted so much, I think.

67. One Part of this recalcined Lime I infused in 12 Parts of Sugar Vinegar, and immediately a greater and more noisy Ebullition ensued than even Lime-crusts occasion. It was indeed soon over; but a Foam remained on the Surface for more than four Days, when

I threw it out. The flaked old Stone-lime, mixed in the same Proportion with the same Vinegar, made no visible Ebullition; though it soon quite destroyed the Acidity of the Vinegar, and made it sweet and thick, almost like a thin Syrup, and pretty much tintured it with a yellowish brown Colour. The Lime was very white, and so appeared to be much penetrated. Calcin'd Oister-shells, which had for some time been infused in Water, and were again dried, treated the same Way, made not a great, but a lasting Ebullition in the Vinegar. The Liquor wherein the old flaked Lime was infused, appeared to be the sweetest of the three. From these Experiments (*a*) may be inferred,

68. *1mo*, That a very small Quantity of Sope-ley cannot be taken inwardly, without great Danger, though diluted with 20 times its Weight of Water, &c. (*b*). *2do*, That flaked Stone-lime may be kept, even in open Vessels, more than eight Months, without becoming unable to communicate to fixed alkaline Salts, a very high Degree of corrosive Acrimony. *3tio*, That those who talk of Quick-lime a little flaked, or expect to abate its Acrimony, by keeping it in a corked Bottle for several Months, seem not to have considered well its Nature. *4to*, That Dr Hartley's Reformation of Mrs Stephens's Medicines, considerably increases their Acrimony, by conjoining a fixed alkaline Salt, and powdered Quick-lime a little flaked, but not their lithontriptic Virtue (*c*), at least proportionally. In Dr Hartley's alkaline Emulsion for the Cure of the Stone, there is indeed no fixed alkaline Salt, except what is contained in the Sope (*d*). And whether its Acrimony will be so much increased by Lime, as it would be if the Salt were not incorporated with Oil, I have not tried: But I think it demonstrated in the *Dissertation* (*e*), that by taking Quick-lime (whether a little or much flaked) in Substance, so much of its Virtues

(*a*) No. 64.—67.

(*b*) *Vid. Ess. p. 191.*

(*c*) *Vid. Ess. p. 2. Note (c), et supra, No. 20.*

(*d*) *Vid. Ess. p. 145.*

(*e*) *p. 41.*

can never be communicated to the Urine, as there may be by drinking the Lime-water.

"My Friend," adds the Doctor, "has further observed, that Quick-lime which has been used in making Sope-ley, gives little or no Virtue to Water (a). This, however, does not happen, because it is so fixed by the alkaline Salt as afterwards not to yield its Virtues to Water, but because the alkaline Solution has almost wholly deprived the restrious Part of the Lime of that *active Principle*, to which its peculiar Taste, Acrimony, and Power of dissolving the Stone, are owing" (b).

69. That the Lime which has been used in making Sope-ley, when freed of the Salt, gives little or nothing to Water, even after it is recalcined, is very true: But that the alkaline Solution, by depriving the Lime of any of its Parts, should make it heavier, without supplying their Place with a larger Portion of its own, must be very wonderful: For thus the alkaline Solution becomes lighter, by uniting to itself the active Principle, and the Lime heavier by parting with it; that is, a Part becomes greater than the whole, in spite of *Euclid*.

By the Experiments, *Diff.* p. 18. & 19. it is evident, that one Part of Water, assisted by a proper Proportion of Potash, either extracts from Quick-lime more of its dissolvable Part than 50 (I may say 500) Parts of plain Water could extract, or it fixes it; that is, it either extracts all that Water can extract, or if it extracts not all, it fixes what it does not extract, so as to render it indissolvable in Water. But the diminished Weight of the alkaline Solution, being inconsistent with the former Part of the Alternative, the latter must be true; for there can be no *Medium*. Hence the Doctor's Account of the Action of alkaline Salts on Quick-lime, and of the Virtues of Sope-leys, and common Caustic, thence explained, have no Foundation (c).

(a) *Diff.* p. 19.

(b) *Ess.* p. 97.

(c) See *Ess.* p. 97. et *supra*, No. 22.

70. For if Sope-ley were a much more powerful Solvent of the Stone than Lime-water, because it consists of a vastly greater Proportion of the *active Principle*, separated from the earthy Part of the Lime, and united to an acrid Salt; then tartarised Lime-water also would be a much more powerful Solvent than plain Lime-water, because it consists of the *active Principle* of the Lime-water, separated from the earthy Part, and united to an acrid Salt. But tartarised Lime-water is a much weaker Solvent of the Stone than plain Lime-water (*a*). The Doctor's Account, therefore, of the Action of alkaline Salts on Quick-lime, explains nothing. He adds,

“ But if this Account of the Constitution of Sope-
 “ leys be true, it may be thought that there should be
 “ no earthy Matter at all in them; and indeed the
 “ Quantity of this is so small, that Mr *Geoffroy* makes
 “ no mention of any calcarious Matter in his *Analysis*
 “ of Sope (*b*). Dr *Hales*, however, having dissolved
 “ 320 Grains of the *Lapis infernalis*, or dry Salt of
 “ Sope-ley, in hot Water, and filtrated the *Lixivium*
 “ through Paper, found 11 Grains of earthy Matter,
 “ that is, $\frac{1}{29}$ Part of the whole; which is about four
 “ times as much as 320 Grains of pure Potash would
 “ have afforded, if it had been treated in the same
 “ Manner. But as the remarkable Virtues of 320
 “ Grains of *Lapis infernalis* cannot be owing to so few
 “ Grains of Quick-lime united with its alkaline Salt,
 “ so it seems certain, that this Salt must receive some-
 “ thing else from Quick-lime. And is it not pro-
 “ bable, that even this small Quantity of Earth pro-
 “ ceeded either from the Impurity of the Ley used by
 “ Dr *Hales*, from the Vessel in which it was evapora-
 “ ted, or from the alkaline Salt” (*c*)? Here several
 Things are observable; as,

71. 1^{mo}, That Mr *Geoffroy*, in the Memoirs cited by the Doctor, mentions, not indeed *calcarious Matter*,

(*a*) *Vid. supra*, No. 22. § 2.

(*b*) *Memoir. acad. des sciences*, an. 1739.

(*c*) *Ess. p. 98.*

but

but plainly (*Chaux*) Lime, as a constituent Part of Sope. For after observing, that *Alicant* Sope is made of a Lixive of Quick-lime and Salt of *Kali*, boiled with Oil Olive to a proper Consistence (*a*), and giving the Proportions, he says expressly, that "the finest Part of the Quick-lime, which must remain in the decanted Ley, ought to be reckoned as a Part of the Mass of Sope" (*b*); and plainly includes it in the Salt, the Quantity whereof he wanted to know: In order to which, he calcined the Sope, whereby the Lime could not be separated from the Salt. But after directing how *Glauber's* Salt may be got from Sope, by means of Oil of Vitriol and Calcination, he adds, "There is found with this *Glauber's* Salt, a Quantity of Lime *assez sensible*, which entered the Sope-ley, and precipitates to the Bottom of the Vessel during the Crytallification. Likewise, when the Sope is calcined by itself, and what remains in the Crucible dissolved in Water, in order to obtain the true Crystals of the Salt of *Kali*, the Lime always separates from the Salt, and precipitates during the Crytallification" (*c*).

72. *2do*, That the Doctor also overlooks Part of Dr *Hales's* Experiments; for he evaporated and dissolved four Ounces of Sope-ley three times. The first Evaporation yielded 320 Grains of dry Salt; whence, by Solution and Filtration, he got 11 Grains of a dry insipid *Calx*. "There remained," says he, "in the filtering Paper 11 Grains of a dry insipid *Calx*, which did not grow moist, not in long standing exposed to the open Air; a Sign that no lixivious Salt remained in it; for it was washed with repeated Quantities of fresh warm Water" (*d*). The filtered Liquor evaporated gave 307 Grains of dry Salt, which, with the 11 Grains of *Calx*, make 318 Grains; so lost of the 320 only two Grains. The 307 Grains of dry

(*a*) *Vid. Ess. p. 4. Note (e), and p. 110.*

(*b*) *Mem. an. 1739, Paris edition, p. 285.*

(*c*) *Ibid. p. 290.*

(*d*) *Hales's Exp. and Obs. p. 8.*

Salt being dissolved and filtered, left seven Grains of *Calx*; and the Solution evaporated afforded 236 Grains of dry Salt; whence, by Solution, &c. he got only two Grains of *Calx*, and proceeded no further. So he had from the 320 Grains of dry Salt, 20 Grains of *Calx*, or a 16th Part of the whole.

73. Now, the seven Grains of *Calx*, added to the 236 Grains of Salt, make but 243 Grains; which deducted from the 307 Grains of dry Salt, there remains 64 Grains; which therefore must have been dissipated in the third Evaporation, though two Grains only were lost in the second: Which is not easily accounted for; unless we suppose, that this great Waste was owing to Part of the Lime's being carried off in the Washings, or some other Way lost accidentally. So that it is not improbable, that Sope-ley contains a greater Proportion of this *Calx* than Dr Hales separated from it; which the Experiments I made, by drying and weighing the *Calces* in the filtering Papers, seem to confirm (a). This *Calx* makes no visible Ebullition in Spirits of Vinegar or Vitriol, though it soon dissolves in either: Whereas the Earth got by evaporating, dissolving, and filtrating a Solution of Potash, makes a strong Ebullition in these Acids. I see no Probability, therefore, that the dry *Calx* proceeded from any thing but the Lime in the Sope-ley.

3^{tho}, As for my Friend's Experiments (b), I shall only say, if a Lixive of Shell-lime and Potash yield no dry *Calx*, on being evaporated, and again dissolved, there is Reason to suspect, that a right Sope-ley cannot thus be prepared. Sure I am, that I cannot make so strong a lithontriptic Lixive with Shell-lime as with Stone-lime (c) *.

74.

(a) Vid. Pref. Diff. p. x. (b) Ess. p. 99.

(c) Vid. Diff. p. 53.

* Since writing what is above, Dr Black shewed me, that the dry *Calx*, which I had kept many Months, might be dissolved in Water, and crystallised: and having dissolved it in a Tea-cup, and set it in the Window, I found, that it shot into very transparent prismatic Crystals, which decrepitate in the Fire, dissolved in Water,
and

74. 4^{to}, That the dry Salt of Sope-ley is improperly called *Lapis infernalis*. Before it can deserve that Name, it must be melted in a Crucible, and boil to the entire Consumption of Humidity, and, in consequence thereof, until it flows like Oil, whereby its corrosive Quality is considerably increased; a Solution of the dry Salt being weaker than the Ley of which it was made, though no more Water be taken than was spent in the Evaporation: At least, by infusing two equal Fragments of the same *Calculus* in equal Quantities of such a Solution, and Sope-ley, seven Days without Heat, I found the lithontriptic Power of the Ley to be to that of the Solution, as 11 to 10. And,

75. 5^{to}, That although it were granted, that there is no earthy Matter at all in Sope-ley, yet the Existence of the *subtile active Principle* could by no means be thence inferred. For I believe it was never imagined, that the remarkable Virtues of Sope-ley, or of *Lapis infernalis*, are owing to the Quantity of Quick-lime united to the alkaline Salt. It is by the Action of Quick-lime on the *Alkali*, that it acquires the *virtus rodendi acutissima promptissimæque, quæ neque fuerat in alcali solo, neque in calce viva sincera* (a). For as, by Fire, Nitre can be turned, either into a volatile acid Spirit, or fixed alkaline Salt; acid Tartar into an *Alkali*; Shells into Quick-lime, &c.; and as by Quick-lime the volatile alkaline Salts of Sal Ammoniac, Urine, &c. are turned into corrosive Spirits, without communicating to them any new Substance: so no doubt Quick-lime chiefly acts on alkaline Salts in Sope-ley, whether any of its earthy Matter be in them or not.

“ Upon the whole,” says the Doctor, “ since Lime “ deprived of its Virtues, and the calcarious Crusts “ thrown up by Lime-water, may, by a new Calcina-

(a) *Vid. Diss. p. 17. and Pref. p. 5. & 6.*

and tasted somewhat salt and bitterish. This Gentleman’s Experiments, which we hope to see soon made public; will no doubt explain this, and several other Things concerning the Nature of Quick-lime, which perhaps were never thought of before.

“ tion,

"tion, be converted again into Quick-lime; is it not
 "probable, that what Lime-stone, Chalk, and Shells,
 "receive from the Fire, is that *active Principle* which
 "gives to Quick-lime and Lime-water their peculiar
 "Taste and most remarkable Virtues, and which is
 "strongly attracted by alkaline Salts, while the earthy
 "Part of Quick-lime is rejected by them?" (a).

76. But old Lime and Lime-crusts, being by a new
 Calcination convertible again into Quick-lime, is so far
 from making it probable, that they receive any new
 Substance from the Fire, and such the Doctor's *active*
Principle must be, since it increases the Weight of
 Lime-water (b), while their Weight is diminished by
 the new Calcination; that, on the contrary, it evi-
 dently proves, that the Fire only changes their Qua-
 lities, without adding any thing to their Substance.

Whether by repeated Calcinations Lime may be so
 attenuated, as to be entirely dissolvable in Water;
 or whether there is in all Quick-lime an incalcinable
 Earth, I cannot determine: But, by all the Trials that
 I have made, Quick-lime never yielded one half of its
 Weight to Water, and seldom above a third (c).

S E C T. VI.

I do not pretend here to take notice of every thing
 wherein my good Friend and I are not quite agreed,
 but only of such Passages in the *Essay* as attack the
Dissertation, or are of more public Concern: As,

77. *imo*, "Quick-lime, Lime-water, and fixed al-
 "caline Salts, not only volatilise the Salts of the U-
 "rine, but also corrupt its Oils; although Quick-lime
 "and its Water produce this Effect, much more re-
 "markably than the alkaline Salt" (d). The Expe-
 riments whence this Inference is drawn, chiefly as to
 the corrupting the Oils, having been made with Shell-
 lime and Shell-lime Water, to these it ought to be re-

(a) *Ess.* p. 100.(c) *Vid. supra*, No. 45.(b) *Ess.* p. 84. & 95.(d) *Ess.* p. 26. See also p. 103. 122.

stricted;

stricted; and as they may well be wanted, I have no Concern to vindicate them.

But that Stone-lime, or Stone-lime Water, corrupt the Oils, is inconsistent with their antiseptic Virtue, and the Experiments, *Diff. p. 17. 26. 32. 34.—37.* Even rancid Sperma Ceti may be recovered by a Sopeley, diluted with Lime-water. The Doctor, however, does not attribute the lithontriptic Virtue of Shell-lime Water solely to these Qualities; being at great Pains to prove, “that the Virtue of Lime, in dissolving the “*Calculus*, proceeds chiefly from the Power it possesses of subtilising and dividing the Salts of this Concretion in such a Manner, as thoroughly to destroy “their Nature and Texture as solid Salts” (*a*). But this Opinion is inconsistent with Experiments (*b*). Besides, to say nothing of Sope, common Water surely has no such Power of subtilising the Salts of the Stone. Yet Mess. *Littre* and *Geoffroy* have long ago observed, that several simple Waters are known to dissolve the Stone, out of the Body (*c*). And I found, that the two Fragments of a *Calculus* infused in common Water in *July 1754* (*d*), in less than a Year had lost of their Weight, when washed and dried, nine Grains, over and above a white shelly Cover which weighed six Grains; the two remaining *Nuclei* weighing together only 15 Grains. So 15 Grains may well be said to have been penetrated by the common Water (*e*), while Shell-lime Water, in the same Time, had penetrated only 18 Grains of a Piece of the same *Calculus*.

78. *2do*, “If the Shells are friable, and quite white, “they are sufficiently burnt” (*f*). But they may have both these Qualities, and yet communicate to Water the detestable *Empyreuma*, which renders it very nauseous, if not hurtful to the Stomach (*g*). Whoever therefore prepares Shell-lime Water, ought to be well ac-

(*a*) *Ess. p. 132.*

(*b*) See *Diff. p. 39.* and No. 22. *supra.*

(*c*) *Vid. Mem. acad. 1720. & 1739.*

(*d*) *Vid. Pref. p. 6. § 4.* (*e*) *Vid. No. 21. supra.*

(*f*) *Ess. p. 34.* (*g*) *Vid. Van Swieten comment. 1. p. 742.*

quainted with its genuine Taste (a). This sulphurous *Empyreuma* is easily discovered by the Smell, as well as by the Taste, and by its discolouring Silver; and when the Water is affected with it, it ought to be thrown out, and the Shells recalcined. For my own Use,

79. I clean the freshest Oister-shells well of every thing adhering to them, and then boil them, for half an Hour or so, in fresh Water; after which I calcine them for six or eight Hours in a strong Fire, and when cold, put them into a sufficient Quantity of cold Water, stirring them well now and then. If next Day the Water does not discolour Silver, and has a right Taste, having by washing freed the Shells of the adhering Ashes, &c. I put them into the Shell-lime Water Vessel; but if empyreumatic, I recalcine them. The Shell of the Oister which is soonest freed of the *Empyreuma*, so far as I have yet observed, is the thin flat one; and the Shells which seem to retain it longest, are such as are full of Holes, as if they were Worm-eaten.

310, "It is observable, that while Lime-water dissolves the Stone, it does not affect biliary Concretions, though much less firm and hard. The Reason is, the former abound much more with Salt than the latter; and we have shown above, that the lithontriptic Virtue of Lime-water is chiefly owing to its peculiar Action on the Salts of the Stone. But a *Lixivium* of Salt of Tartar, although it has little Influence on the *Calculus*, dissolves the biliary Concretions; because the alkaline Salts unite readily with Oil, which is the Principle that abounds most in them. If Lime-water dissolved the *Calculus* by its penetrating Detergency, as some have thought, ought not biliary Concretions to be dissolved by it, since they are more likely to yield to a penetrating detergent *Menstruum*, than urinary Stones" (b)? But,

80. It is no less observable, that the Firmness,

(a) *Vid.* Diff. p. 14. and Pref. p. viii. & ix.

(b) *Ess.* p. 133. 134.

Hardness, and other manifest Qualities of Bodies, can afford no certain Mark or Indication of the Qualities of the Liquors requisite to dissolve them, but Experience only (a). The Powers of *Menstruums* are not to be determined by what they are likely to do, but by what they are found to do. Yet even the penetrating Detergency of Lime-water, does not make it likely to dissolve biliary Concretions, the Bile itself being a penetrating Detergent, in which they are formed. It is needless here to inquire, which of these Concretions abounds most with Salt, since it is shewn above, N° 22. that the lithontriptic Virtue of Lime-water, cannot be owing to its peculiar Action on the Salts of the Stone. And by the Doctor's Experiment, *Eff.* p. 119. § 74. it appears, that alkaline Salts do not very readily unite even with Vegetable Oils, far less with Animal Oils (b). Yea, since, according to the Doctor, Lime-water has penetrating, dissolving, and detergent Qualities (c); acts on the *Calculus* partly by extracting its Oil (d); and the Particles of Shell-lime are saponaceous, &c. (e); it by no means appears unlikely, even by his own Doctrine, that Lime-water acts on the Stone by its penetrating Detergency*.

80. I have been told of Lime-water's having had "good Effects in low nervous Fevers; but in ardent and putrid Fevers it ought to be hurtful, on account of its Power of volatilising the Salts, and corrupting the Oils" (f).

81. If Shell-lime Water, on these Accounts, ought to be hurtful in ardent and putrid Fevers, ought it not to be hurtful also in the *Scrophule*, Dysentery, inward Ulcers, &c. (g)? But Stone-lime Water, on account

(a) *Vid.* *Phys. Ess.* p. 287.

(b) *Vid.* *Hales's Exp.* p. 7. or *Diff.* p. 17.

(c) *Ess.* p. 102.

(f) *Ess.* p. 103.

(d) *Ess.* p. 120.

(g) *Vid.* *Ess.* p. 102.

(e) *Ess.* p. 113.

* *E calce viva paratur aqua, mirifica virtutis ad ambustiones, fistulas, cancrum, maculas et rubedinem oculorum, et ad vestium byssinarum maculas auferendas; hoc modo. Recipe, &c.* (ut in *Diff.* p. 29.). De Boot, p. 523.

of its antiseptic, detergent, and diuretic Powers, purifying and rectifying both the Salts and Oils of the Animal Humours, ought rather to be helpful in all these Diseases. I have known, as well as been told, of its good Effects in several Diseases, acute as well as chronic. And an experienced Surgeon (Mr. J. K.) lately acquainted me with its Success in an inveterate *fluxus mensium nimius*, which returned every three Weeks, or eight Days sooner than the common Period, lasted six Days in great Abundance, and obstinately continued, notwithstanding the Use of various Astringents, &c. prescribed by Physicians, both outwardly and inwardly; till finding her Strength still declining, she wearied of all Medicines, and gave them over: But being persuaded, at length, to take an *English* Pint of Stone-lime Water every Day, beginning after the Flux was over, and continuing it for three Weeks, it proved an effectual Cure. And he has had two other Instances of its Success in the same Disease. Which Cures I thought it not improper to mention, because of a Disease not easily overcome, and by a Method not commonly practised. In a Word, I know no Distemper wherein common Water is not hurtful, in which Stone-lime Water is not safe; though often safe and beneficial where common Water is not.

510, "The disagreeable Taste of Lime-water is quite destroyed, by washing one's Mouth, immediately after drinking it, with a little Vinegar and Water (a).—The Patient should drink no more of any

(a) Eff. p. 137.

* Nicajus le Febure, speaking, in his *Body of Chymistry*, of the Virtues of a Preparation of Quick-lime, says, "that those who shall use it, either for a Remedy or for a Dissolvent, may very well be cast into Astonishment and Wonder, that Nature should have hid so high a Mystery, in so vile, so contemptible a Subject as Quick-lime is; which hath caused Paracelsus to say, by an Act of Reflection and great Wonder, that some do throw away and kick with their feet such a Stone or Flint, as would be to him a greater Revenue than a Cow, did he know the Mysteries which God and Nature hath concealed and laid therein." *Hales's Ex- per. and Obs. p. 30.*

" other

" other Liquor than is necessary to quench his Thirst
" (a).—If the Sope and Lime-water shall occasion
" a greater Heat and Thirst than usual, 30 or 40
" Drops of dulcified Spirit of Nitre, may be taken in a
" Draught of Lime-water twice or thrice a-day" (b).

82. These are friendly Directions, but I believe seldom if ever wanted. The true Taste of Lime-water is not disagreeable, if the Mouth be clean; and though foul, only for a Moment, even to such as are unaccustomed to it, leaving a much more agreeable Flavour behind it than either Vinegar or Wine; no Liquor so effectually destroying a disagreeable Taste as does Lime-water; which at the same time is one of the best Medicines for the Teeth, but Vinegar one of the worst. And so far is Lime-water from causing Heat or Thirst, if too much Sope be not taken, that it cools and quenches as effectually as common Water. There can, therefore, be no need of drinking any thing else during the Use of it for the Stone, far less of dulcified acid Spirits.

6to, " Having given an Instance of the Success of
" Lime-water in dissolving the Stone, and illustrated
" its Virtue this Way by a Variety of Experiments;
" in the Course of which we have been so lucky as to
" discover the remarkable Virtue of Oister and Cockle
" Shell Lime above Stone-lime; it remains that a Method of Cure be laid down, founded upon the above
" History and Experiments. *First*, then, I would advise the Patient to swallow every Day an Ounce of
" the internal Part of *Alicant* Sope, and drink three
" *English* Pints, or more, of Oister or Cockle Shell
" Lime Water" (c).

83. But that this Advice is not founded on the History and Experiments referred to, and that the surest and speediest Effects of Lime-water and Sope in the Cure of the Stone, are not to be obtained by it (d), will appear, if we consider,

(a) Eff. p. 142.

(b) Ibid.

(c) Eff. p. 136.

(d) Vid. Phys. Eff. p. 384.

1^{mo}, That the History here mentioned, or Instance of the Success of Lime-water in dissolving the Stone, is that of Mr *David Millar*, related *Eff. p. 5.—16.* who was cured by Sope and Stone-lime Water (*a*), and, so far as appears, never tasted Shell-lime Water, nor made any Difference between the external and internal Parts of *Alicant* Sope.

2^{do}, That, by the Doctor's Experiments, not only Stone-lime Water (*b*), but also the Solution of *Alicant* Sope in common Water by itself, is as strong a Solvent of the Stone as Shell-lime Water. For he found, that a seven Grains Piece of the very hard *Calculus B*, put in a Solution of this Sope, and kept in a gentle Heat for 96 Hours, lost two Grains of its Weight (*c*); while a 10 Grains Piece of a very hard *Calculus*, kept 93 Hours in warm Shell-lime Water, lost only somewhat more than $1\frac{1}{2}$ Grains. The dissolving Power therefore of a Solution of *Alicant* Sope in common Water, is to that of Shell-lime Water, as 19 to 15.

3^{tio}, That the dissolving Power of a Solution of *Alicant* Sope in Stone-lime Water, is much greater than that of double Shell-lime Water. For whereas a 10 Grains Fragment of a *Calculus* in 93 Hours warm Digestion, in double Shell-lime Water, had but two Grains of its Substance dissolved or rotten (*d*); "a Piece of the *Calculus A*, of 18 Grains, after lying five Days in a Solution of *Alicant* Sope in Stone-lime Water, in a moderate Heat, was reduced to six Grains" (*e*). The Virtue, therefore, of this Solution is to that of double Shell-lime Water, as 9 to 2, by these Experiments. And,

4^{to}, That "neither Oyster-shell nor Cockle-shell Lime-water seem to have their Virtue sensibly increased by the Sope" (*f*); whereas "we ought to consider the Stone-lime Water, in Mr *Millar's* Case, as having had its Efficacy in a good measure heightened

(*a*) *Vid. Eff. p. 112.*

(*b*) *Vid. supra, No. 3. & 4.*

(*c*) *Vid. Eff. p. 27. & 115.*

(*d*) *Eff. p. 47.*

(*e*) *Eff. p. 111.*

(*f*) *Eff. p. 113.*

“ by its being taken along with a considerable Quantity of Sope,” (a).

84. Such therefore as take Sope for the Cure of the Stone, have no Occasion at all for Shell-lime Water. Fountain-water will do as well, by the Doctor's Experiments. But if they want a Medicine that “ has “ a greater dissolving Power than either a Solution of “ Sope in common Water, or Lime-water by itself, “ or even the Aggregate of the dissolving Powers of “ Sope and Lime-water when unmixed” (b), let them take Stone-lime Water only along with the Sope. Shell-lime Water, therefore, agreeably to the History and Experiments, ought to be scored out of the Doctor's Advice, and Stone-lime Water inserted in its Place; which, on many other Accounts, is preferable (c), to say nothing of its being more easily prepared, and never affected with the *Empyreuma*. And,

85. If my Advice can be acceptable to such Patients, as have either a Stone in the Bladder, or Gravel in the Kidneys, with whom I cannot but sympathise, having had some Experience of their Trouble, as well as of the Remedy; it is in short this. Let them drink Stone-lime Water liberally, and no other Liquor, either by itself, or with their Victuals, its Success depending chiefly on its Influence on the Constitution; taking along with it only as much *Alicant* Sope as will keep their Belly easy, (and if accustomed to strong Liquors, a Dram, if needful, may be now and then allowed): For these, “ by destroying “ the petrifying Quality in the Urine, will hinder any new “ Accretions to the *Calculus*, which must in Time have “ its Surface washed down, and worn away, by the “ Urine continually running along it” (d). But if their Stomachs cannot bear Sope, it may be omitted, and the Lime-water only continued. And if even the Lime-water much increases the Pains, as sometimes happens, let them neither neglect the Use of the Catheter, when the Urine is obstructed, nor delay too long

(a) Ess. p. 112.

(b) Ess. p. 111.

(c) Vid. No. 9. *supra*.

(d) Ess. p. 23.

to be cut; Lithotomy being now so dextrously, as well as successfully performed, both on the old and the young, that it is far from being so terrible or dangerous an Operation as People generally imagine.

Many Instances might be given, were this a proper Place for it; but a very singular one I cannot omit. A man about 36 Years old, who had been afflicted with the Gravel from his Infancy, was cut in *December* last by Mr *Peter Adie*, and a Stone taken from him, of about seven Ounces Weight; to which a large Piece of the Bladder adhered so closely, that it was brought to the Orifice of the Incision, and cautiously separated by the Operator's Fingers: Yet the Patient recovered, and continues in Health.

On reviewing the *Dissertation*, I observed some Passages in it which want to be explained or corrected, viz.

1^{mo}, "Quick-lime, whether flaked or unflaked, makes an Ebullition, or effervesces with, and destroys Acids" (a). This Mr *Lemery* asserts (b); and it appears to be true of Shell-lime. But unless it be understood to signify no more than antacid or absorbent, it is not strictly true, at least, of all Stone-lime (c).

2^{do}, "One Pound of fresh well-burnt Calx vive, of any Kind, is enough for a Hoghead of Water" (d); to wit, to prevent the Water's putrifying and breeding Vermine. If in place of Calx vive of any Kind, it had been Stone Calx vive, such, viz. as we use here, it is supported by all the Experiments that I have yet made: But that Chalk or Shell Quick-lime will have that Effect, I am not so certain (e).

3^{tio}, "The lithontriptic Power of Lime-water may be increased, though with Danger, by adding to it less or more of an alkaline Salt" (f). But by later Experiments I have found, that a very small Proportion

(a) p. 16.

(b) Chym. p. 384.

(c) Vid. supra, No. 67.

(d) p. 33.

(e) Vid. No. 9. supra.

(f) p. 74.

of alkaline fixed Salt, mixed with Lime-water, much increases its Acrimony, but diminishes its lithontriptic Virtue, or Action on the Stone (a). 419, "Since the Attempt to sweeten Sea-water is renewed, it is not improbable, that Quick-lime may supply the Place of Mr Appleby's *Lapis infernalis* and "calcined Bones" (b). That Salt-water may be made fresh by a simple Distillation, has been known ever since the Nature of Salt, and of that Process, was discovered, and confirmed by the great Mr Boyle's Experiments many Years ago: But that Sea-water, thus freed of the Salt, is as wholesome as common Water, whether distilled by itself or Mr Appleby's Way, is not yet so certain. But since Mr Appleby's fixed *Alkali* prepared with Quick-lime, as strong as *Lapis infernalis*, and calcined Bones, cannot more effectually than Quick-lime alone, prevent the rising of bituminous Matter, if there be any such in the Sea-water, as Mr Appleby conceived; nor more entirely dissipate any volatile urinous Spirit, which may more reasonably be suspected to be retained in this distilled Water, as Mr Clark observes (c); and since a Solution of *Saccharum Saturni* dropped into it, turned it turbid and milky, as the same learned Gentleman notices (d), while it had no such Effect on the Sea-water distilled from Quick-lime: it is more than probable, that the Water thus distilled, will be more wholesome than that distilled from *Lapis infernalis*, being found purer by the severest Tests known. And I can now add, that the Water thus distilled, which I have kept full nine Months in a large Glass Phial, continues as sweet and free of Corruption as at first.

I caused distil Sea-water also from Chalk: But though this Water did not become turbid or milky, on dropping into it a Solution of corrosive sublimate in Water; yet a small Quantity of a Solution of *Saccharum Saturni* being mixed with it, it became whitish, and precipitated something like a white Powder, very visible on

(a) Vid. No. 22. supra. (b) Vid. Pref. to Diff. p. viii.

(c) Phil. Transf. vol. 48. p. 70. (d) Ibid.

the Sides and Bottom of the Glasse, which Solution had no such Effect on the Sea-water distilled from Quick-lime, at least when the Water was suffered to boil a few Minutes before the Application of the Recipient.

But this Solution being old, and not very strong, I made a fresh one, of one Part *Saccharum*, and about seven Parts Water, and filtered it. Into a Spoonful of the Sea-water distilled off Quicklime, I dropt 10 or 12 Drops of this Solution of the Sugar of Lead; and the Mixture had much the same Appearance with the foregoing. Into a Spoonful of our Fountain-water I dropt the same Quantity of the Solution, as also into a Spoonful of the Sea-water distilled from Chalk. Both became immediately equally turbid, and much whiter than the former. Quick-lime, therefore, appears to be preferable also to Chalk in this Process. But at the same time it must be observed, that neither Spirit of Vinegar, nor Spirit of Vitsiol, clarify any of these Mixtures, but, on the contrary, turn them more turbid and milky, increasing considerably the Precipitation. And to conclude:

510. The *Magnesia alba*, or that alkaline Earth which is the Basis of Sea-salt, &c. (a). This Substance is evidently the Basis of one of the Salts got from Sea-water, but not of that in common Use; so it ought to be rather called the Basis of the bitter Sea-salt, or of Epsom Salt.

(a) *Phil. p. iv.*



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